WATER & SEWAGE WORKS

WATER WORKS WOMAN OF THE YEAR

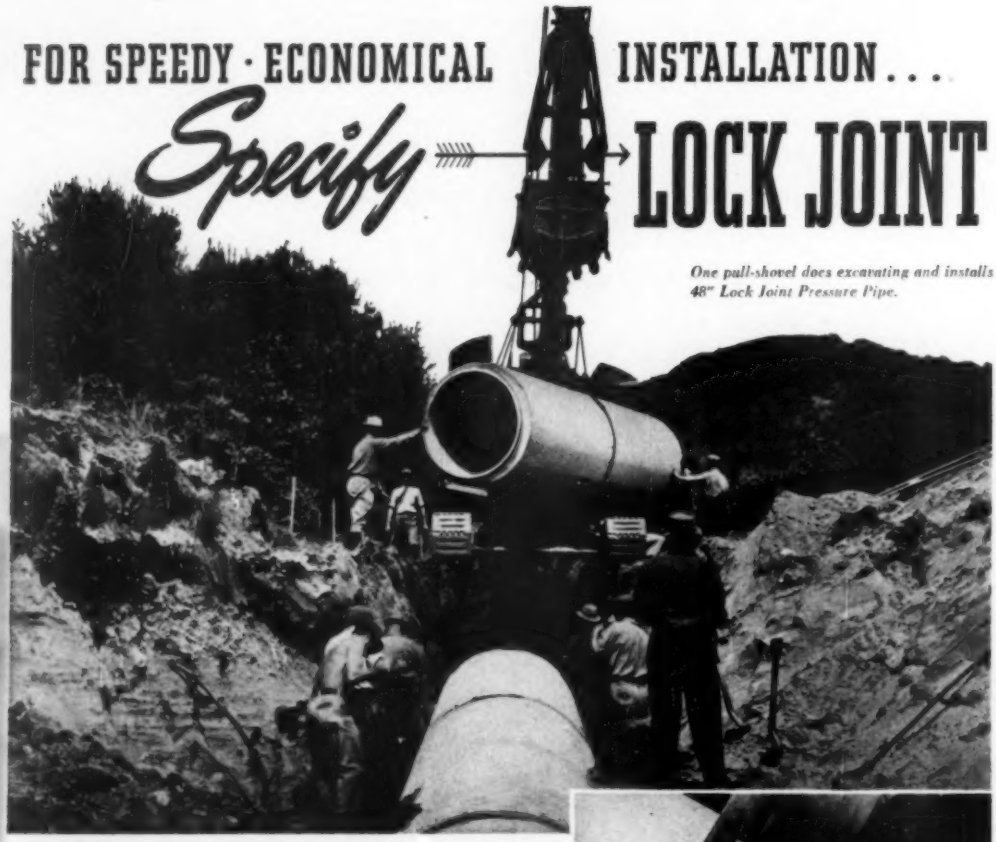
Lois Sutherland
Manager
PADUCAH, KY.

*Section 2 is the 1949 Index

FOR SPEEDY · ECONOMICAL INSTALLATION . . .

Specify LOCK JOINT

One pull-shovel does excavating and installs 48" Lock Joint Pressure Pipe.



• • • With its exclusive Rubber and Steel Joint, Lock Joint Reinforced Concrete Pressure Pipe is installed rapidly and efficiently in extremes of heat or cold—in wet ditch or dry.

Only one machine is required to make the excavation and install the pipe. No caulking or bolting of the joint is necessary, and the pipe may be back-filled immediately. The Rubber and Steel self-centering expansion joint is flexible to accommodate ground settlement, and is watertight at any internal pressures common to American Water Works practice.

Today, millions of feet of Lock Joint Reinforced Concrete Pressure Pipe, equipped with the Rubber and Steel Joint, installed at low cost and needing little or no maintenance, are giving unfailing service throughout the Western hemisphere.

Rubber and Steel Joint ready to be pushed home.

LOCK JOINT PIPE COMPANY

Est. 1905

P.O. Box 849, East Orange, N. J.

PRESSURE PIPE PLANTS: Wharton, N. J. • Turner, Kan. • Detroit, Mich.

BRANCH OFFICES: Cheyenne, Wyo. • Denver, Colo. • Kansas City, Mo. • Valley Park, Mo. • Chicago, Ill. • Rock Island, Ill. Wichita, Kan. • Kenilworth, N. J. • Hartford, Conn.

SCOPE OF SERVICES—Lock Joint Pipe Company specializes in the manufacture and installation of Reinforced Concrete Pressure Pipe for Water Supply and Distribution Mains in a wide range of diameters as well as Concrete Pipe of all types for Sanitary Sewers, Storm Drains, Culverts and Subaqueous Lines.

LOCK JOINT
Reinforced Concrete
PRESSURE PIPE

WATER AND SEWAGE WORKS. Reg. U. S. Patent Off. January, 1950. Volume 97. Number 1. Published monthly by Gillette Publishing Co., at 404 North Wesley Ave., Mount Morris, Ill. Per copy, 25c; Subscription rate: United States, $2.00 per year; Canada, $2.00 per year; Foreign, $3.00 per year. Entered as second class matter March 4, 1948, at the post office at Mount Morris, Illinois, under Act of March 3, 1879.
Executive and business offices, 22 W. Maple St., Chicago 10, Illinois. Editorial office, 155 E. 44th St., New York 17, N. Y.

Bill to Require Water Meters in All Homes

Maps Plan to End Long Spigot Binge, Avert Crises

...Party Wins Vote

EVEN WATER IS SHORT

IN RECENT YEARS, there has been considerable speculation, along with some presumably accurate estimates, about the depletion of various national resources. Little or nothing has been done, however, about a possible shortage of water. But the demand for water has increased 150 ...it is said to have increased 150 ...the last 15 years, on a na...

...develops that ...ers have ...ject.

Water Short In Many Parts Of Nation

Basic Supply Down In Western Sections

The nation's most precious resource, water, is running short in many sections, a survey showed today.

In a few cases, such as at New York, the water shortage is a temporary matter, caused by a lack of rainfall.

But in vast...

DEMAND FOR WATER FETTERS ECONOMY

National Survey Shows High and Unplanned Rises, With a Lopsided Distribution

The United States faces heavy economic losses in the foreseeable future because of unplanned, excessive increases in the use of its most precious mineral resource—water.

In recent years, overdevelopment of ground water resources by industry, more widespread use of air conditioning, overdevelopment for irrigation fostered by high

"You never miss water 'til the well runs dry"

N RATIONS WATER IN DROUGHT

RAIN, which has been affecting the water supplies of several stern seaboard states, hits the town of Roosevelt, N. J., where the wells have gone dry. Here, a number of residents form a "bucket ...aiting to get their share of water transported by two fire trucks ...e city of Highstown, which is ten miles away.

CITY IS OUTGROWING YIEL

...ation by ...ng-Term Ba ...ently Needs

...er consump ...e "norma ...000,000 gal ...stantial ra ...eeks, Nev ...ave only

The Health Department today informed the World-Telegram that the average person in this city—and that includes adults and little children, too—uses 110 gallons of water a day in the home.

Don't Have to Pay.

It is doubtful, authorities said, that New Yorkers are any cleaner than residents of other cities. They are just profligate of water because they don't have to pay for it officials agree.

Where domestic users have metered water service everyone is more careful since every extra gallon means money out of pocket. There are some homes in this city and many more just outside where each house has an individual meter. In hese areas the average per capita consumption of water is from 50 to 75 gallons a day.

A survey of consumption in districts served by the Jamaica Water Supply Co. and the New York Water Service Corp. of Woodhaven, both in Queens, revealed that householders don't waste water when they are paying for it themselves. The same fact was borne out in Lynbrook, L. I., a Nassau County community served by the Long Island Water Corp.

Start Metering Now!

When there have been water shortages in past years, New York City has played around with some system to meter water used in residences. Then when plenty of rain or snow came, the whole thing was dropped until the next drought reminded officials again that metering might be a good idea.

As a result of this backing and filling, the city has made it easy for a careless public to waste some 200,000,000 gallons of water every day. Now, that waste has got us into a critical water shortage.

Even though there is only enough water in the reservoirs to last 60 days, New Yorkers go on being among the worst water wasters in the country. They flush toilets for a match or a cigaret butt. They wash dishes under an open tap. They find scores of ways to fritter away what's left of the supply. For the most part they seem indifferent to the danger threatening their own precious water.

Meters would provide the only way we see to bring that danger home to the public. With meters, people who waste water pay for it.

In New York suburban areas where water is metered, each person uses from 50-75 gallons daily. But in the city, where the supply is free, the average is 110 gallons every day.

One startling fact about the huge consumption is that at least a quarter of the water is wasted. About 7% is lost before it ever gets to consumers—by leakage from the city's underground mains and pipes. Beyond that, the city estimates that about 20% of the water that does get to users is wasted due to leaky faucets and similar carelessness.

• **Metering**—Officials of the Dept. of Water Supply, Gas & Electricity think metering of water would stop a lot of this waste, and might thus prevent such ...es as today's. But with metering ...metering for domes... base.

CAN YOU AFFORD TO BE WITHOUT METER CONTROL?

The serious water shortage in New York City has dramatized the fact that water supply levels are receding nationwide.

Many municipalities have lost or are losing an adequate supply of water through needless waste. Extravagant usage only occurs where the water system is not fully metered. If your system is one of these, don't wait until it's too late. We've prepared a complete program that will help you present the true facts on the advantages of 100 per cent metering to your customers and municipal authorities. Write today—no obligation involved.

Pittsburgh Equitable Meter Division
ROCKWELL MANUFACTURING COMPANY
PITTSBURGH 8, PA.

Double-Duty
TROUBLE SHOOTER

Sanitation HTH is the handiest trouble-shooting assistant you could want. Use double-duty HTH for dozens of daily sanitation jobs as well as disaster-size emergencies. Water works men all over the country have found it pays to stock enough HTH for quick, on-the-spot chlorination—anywhere, anytime. A free copy of Mathieson's 48-page manual—"Hypo-Chlorination of Water"—is waiting for you. Write for it. Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Maryland.

Mathieson
SANITATION HTH

WATER & SEWAGE WORKS

WATER SUPPLY—SEWAGE DISPOSAL—INDUSTRIAL WASTE TREATMENT

E. S. GILLETTE, Publisher

L. H. ENSLOW, Editor

"Water Works Woman of the Year"

(This Month's Cover)

Miss Lois Sutherland, manager of the municipally owned Paducah, Ky., water works, earns the title "Water Works Woman of the year," on the grounds that she enjoys the distinction of being the first and only woman to have served as chairman of a section of A.W.W.A. She has just creditably completed a term as Chairman of the Ky.-Tenn. Section of A.W.W.A.

Miss Sutherland became bookkeeper, chief clerk and treasurer of the Paducah Water Works in 1930 when the city purchased the privately owned system. Upon retirement of James P. Smith as Chairman of the Water Commission in 1932, Miss Sutherland was made manager for the Water Commission. Although her official title remains treasurer, Miss Sutherland directs the affairs of the entire organization under the three-man water commission. She has been a member of A.W.W.A. since 1934 and hasn't missed a single meeting of her Ky.-Tenn. Section since her first in 1933, and attends most of the national meetings.

COMING

Progress in Sewage & Industrial Wastes Treatment—1949

As in past years progress and developments in sewage and industrial wastes treatment will be featured in our February, 1950, issue. As this year's reviewer, we have been fortunate in securing the President of the Federation of Sewage Works Ass'ns.—

ARTHUR H. NILES, Sup't.,
Sewage Works, Toledo, Ohio.

Service Line and Extension Trencher

Interesting and timely is the description of a Jeep-mounted trencher, which has proved so handy for making water service line installations and small main extensions, with material savings in labor costs and time. Some cost comparisons indicate where and how this useful piece of equipment can most effectively be employed. The author is—

H. E. LORDLEY, Asst. Director,
Dept. of Utilities, Richmond, Va.

Bio-Oxidation in Two Stages—A West Coast Development

The new sewage treatment plant of Chula Vista, Calif., is the first of its kind. The "Dual Stage Bio-Oxidation Process" employed represents a novel West Coast development in which flexibility of plant operation and performance to meet local or seasonal requirements, as well as economy in construction and operation, are the salient features. A description of the plant and early operating results are set forth by—

W. T. WRIGHT, Cons. Engr.,
Kistner, Curtis & Wright, Los Angeles.

What's New About Up-flow Clarifiers?

This is the question asked (and answered) by a patent attorney who has dug back into the history and development of conical bottom up-flow clarification units for water and sewage treatment. Interestingly, the first unit of the kind to be put to practical use was the Dortmund Tank of 1880 which was employed for sewage clarification and, incidentally, was never patented. From this disclosure to the present status of the modern up-flow sludge blanket type of clarifier the article is extremely interesting and illuminating. The author is—

FRANK D. PRAGER,
Patent Attorney of Chicago.

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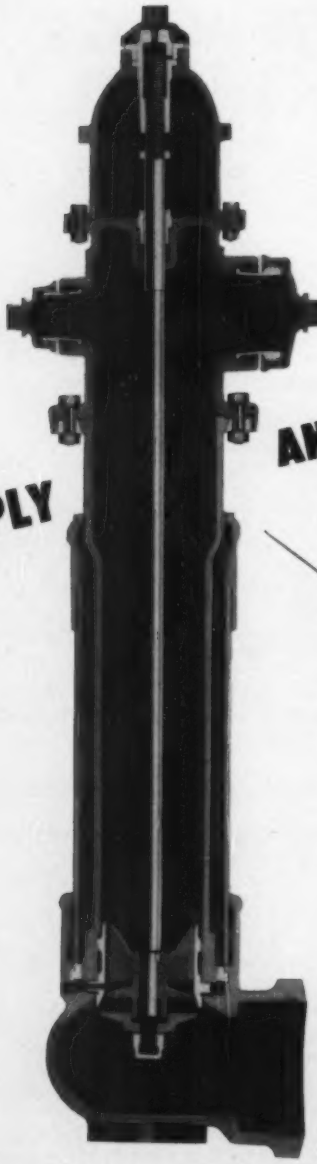
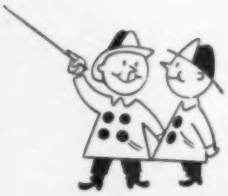


SIMPLY AND SOUNDLY CONSTRUCTED



Simplicity of construction pays off in dependability and ease of maintenance.

MATHEWS MODERNIZED HYDRANTS SET THE PACE: All working parts contained in replaceable barrel • Stuffing box cast integral with nozzle section • Head can be turned 360° • Replaceable head • Nozzle outlets easily changed • Nozzle levels raised or lowered without excavating • Protection case of "Sand-Spun" cast iron for extra strength, toughness, elasticity • Operating thread only part to be lubricated • A modern barrel makes an old Mathews good as new

MATHEWS HYDRANTS

THE FIREMAN'S FRIEND

Made by R. D. Wood Company

Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

Who benefits from Quality Control?

What is Quality Control? What does it do? How does it function? Whom does it benefit?

First and foremost, a quality control operation benefits the customer. It also benefits the manufacturer. It provides assurance to management that the quality level of production is equal to, and generally in excess of, the standard specification.

Take us, for example. We manufacture cast iron pressure pipe in accordance with quality control specifications that are more comprehensive and exacting than the accepted technical specifications or customer's specifications under which pipe is purchased.

The first step in Quality Control is that of establishing company standards for both process methods and the physical and chemical properties of the product.

The next, backing-up step is establishing inspection procedures using statistical sampling techniques. These procedures extend from raw materials to finished product.

The final step is to have our Quality Control Dept. establish a group of facts in statistical form and analyze them for the purpose of removing quality standards from the realm of *opinion* into that of *organized facts.*

Production testing laboratories in our various plants are the tools for evaluating these quality standards.

U.S. PIPE & FOUNDRY CO., GENERAL OFFICES, BURLINGTON, N. J.
America's largest producer of cast iron pressure pipe

Bulletin on POROUS MEDIA by CARBORUNDUM

TRADE MARK

NO. 6 JANUARY, 1950

Over 200 ALOXITE Porous Underdrain Installations NOW IN USE

Introduced in 1934, the first full scale installation of the ALOXITE aluminum oxide porous plate filter bottom was made in 1936. Since then it has achieved universal interest and acceptance.

This system is now used in 34 states and 13 foreign countries. Current installations number well over 200...not including the many additional small filters sold by manufacturers of complete units that incorporate ALOXITE porous plates. Of this total, about 60% are for municipal water supplies, about 25% are industrial supply installations and swimming pools account for the remaining 15%.

Extensive adoption of the ALOXITE porous underdrain system is forceful proof of its general basic appeal. Waterworks engineers everywhere welcome a construction eliminating all graded gravel. Its use avoids costly difficulties resulting from upsetting and loss of media, non-uniform backwashing, short filtering runs and excessive time and money devoted to maintenance.

ALOXITE porous plates have been adapted successfully to large and small gravity and pressure units. They can be fitted to both old and new structures with equal benefit.

Properties of ALOXITE Porous Media

MATERIAL	Ceramically bonded crystalline aluminum oxide grain of controlled size.
GRADES (Pore size)	Filter Underdrains... coarse and very coarse. Direct Filtration... range from very fine to medium. Diatomite Support... range from fine to medium. Air (gas) Diffusion... range from fine to coarse (permeability from 10 to 120.)
SOLUBILITY	In Water and Air... insoluble at all normal operating temperatures. In Acids... generally resistant at all operating temperatures, except to hydrofluoric acid. In Alkaline Solutions... ceramic bonds are progressively soluble with time and temperature increase.
STRENGTH	Transverse breaking strength is relatively good ranging from 1000 lbs./sq. in. (coarse grades) to 3000 lbs./sq. in. (fine grades).
REFRACTORINESS	All grades withstand up to 900° C. without softening.
THERMAL SHOCK RESISTANCE	Withstand changes up to 20° C./hr. (Where more severe heat shock exists, ceramically bonded silicon carbide porous media are available.)
POROSITY	Ratio of pore volume to total volume of all grades approximately 35%.
WEIGHT	Approximately 0.09 lbs./cu. in.

"Carborundum" and "Aloxite" are registered trademarks which indicate manufacture by The Carborundum Company

POROUS BOTTOM TRICKLES...

Recent installations of ALOXITE underdrains have been made by these municipalities: Barberton, Ohio; Shelbyville, Ky.; Columbia, Ky.; Midland, Mich.; Springfield, Tenn.; Carbondale, Ill.; Sutherlin, Oreg.; Old Town, Me. and Keyport, N. J.

Recent purchases of ALOXITE underdrains are for these municipalities: Alexandria, Va.; Rock Island, Ill.; Searcy, Ark.; West Frankort, Ill.; Roseburg, Oreg.; Bucyrus, Ohio; Raton, N. Mex.; and Sunnyside, Wash.

Recent prominent industrial installations are: Eastman Kodak Company, The Neville Co., Kimberly Clark Corp. and Mathieson Chemical Corp.

ALOXITE plates, of different grades, are available to support the variety of media now in use: i. e. filter sand, zeolite and ion exchange materials.

TECHNICAL DATA

on porous media and their application is available on request. You may obtain any or all of the following engineering bulletins by writing Dept. 10-129.

No. 1 Aeration of Sewage and Water.

No. 2 Underdrain Systems for Filters and Softeners.

No. 3 General Catalog information.

THE CARBORUNDUM COMPANY
Refractories Division
PERTH AMBOY, NEW JERSEY

Horton elevated tanks are available in capacities from 15,000 to 3,000,000 gallons. Write the nearest office for full details on these tanks.

DUMAS does much to improve water service

✓ *provides gravity water pressure*—Dumas, Texas recently increased the total amount of storage in elevated tanks in its water system to 350,000 gals. by installing the 300,000-gal. Horton* tank shown at the left. This tank was one of the major improvements effected since a City Commission took over management of the system in May, 1947. Other improvements include a new 325,000-gal. reservoir, three deep wells, and nine more miles of distribution mains.

✓ *meets huge increase in demand*—Since 1947, the number of customers served has increased from 765 to 1350, a jump of 75 per cent. Average daily consumption has risen from 380 to 425 gallons per customer. The water works engineers at Dumas state that elevated storage was a big factor in the successful handling of these increases.

✓ *lowers fire insurance rates*—The 1949 key rate is $0.42 compared to $0.56 in 1946—that's a drop of 33⅓ per cent. Every property owner in Dumas now pays less for his fire insurance—thanks to the protection provided by this Horton tank and other improvements.

Why are so many cities modernizing their water distribution systems with elevated tanks? Because the reserve in a Horton tank provides an extra margin which can be used to meet peak loads and smooth out pressure fluctuations. This reserve is always available for fire protection too—and that often lowers insurance rates.

**Trademark Registered at U. S. Patent Office*

CHICAGO BRIDGE & IRON COMPANY

Atlanta 3 ..... 2181 Healey Building
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Chicago 4 ..... 2190 McCormick Building
Cleveland 15 ..... 2262 Guildhall Building
Detroit 26 ..... 1551 Lafayette Building
Houston 2 ..... 2115 National Standard Building
Havana ..... 402 Abreu Building
Los Angeles 14 ..... 1555 General Petroleum Building
New York 6 ..... 3390—165 Broadway Building
Philadelphia 3 ..... 1644—1700 Walnut Street Building
Salt Lake City 1 ..... 1550 First Security Bank Building
San Francisco 11 ..... 1283—22 Battery Street Building
Seattle 1 ..... 1350 Henry Building
Tulsa 3 ..... 1646 Hunt Building

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

THE MEMBERSHIP OF A C.I.P. Century Club now has

The Cast Iron Pipe Century Club is probably the most unique club in the world. Membership is limited to municipal, or privately-owned, gas and water supply systems having cast iron mains in service for a century or more.

Although the Club is formally established, there are no dues, no regular meetings, and no obligations other than to inform the Recording Secretary if and

CAST IRON PIPE

DISTINGUISHED CLUB...
29 Members!

when the qualifying gas or water main is taken out of service, or, sold for re-use.

In spite of the unique requirement for membership, the Club roster grows, year by year. And why not, when answers to a questionnaire, mailed to gas officials in 43 large cities, show that *original* cast iron mains are still in service in 29 of the cities. And a survey sponsored by three water works associations, indicates that 96% of all 6-inch and larger cast iron water mains ever laid in 25 representative cities are still in service.

If your records show a cast iron main in service, laid a century or more ago, the Club invites you to send for a handsome framed Certificate of Honorary Membership. Address Thomas F. Wolfe, Recording Secretary, Cast Iron Pipe Century Club, Peoples Gas Bldg., Chicago 3, Illinois.

CLUB ROSTER

BUREAU OF WATER, DEPT. OF PUBLIC WORKS
Baltimore, Maryland

CONSOLIDATED GAS ELECTRIC LIGHT & POWER CO.
Baltimore, Maryland

PUBLIC WORKS DEPT., WATER DIVISION
Boston, Massachusetts

BOSTON CONSOLIDATED GAS CO.
Boston, Massachusetts

BOARD OF WATER COMMISSIONERS
Detroit, Michigan

FALL RIVER GAS WORKS COMPANY
Fall River, Massachusetts

CITY OF FREDERICK WATER DEPT.
Frederick, Maryland

THE HARTFORD GAS COMPANY
Hartford, Connecticut

BUREAU OF WATER
Lancaster, Pennsylvania

LOUISVILLE GAS & ELECTRIC CO.
Louisville, Kentucky

CITY OF LYNCHBURG WATER DEPARTMENT
Lynchburg, Virginia

MOBILE GAS SERVICE CORP.
Mobile, Alabama

MOBILE WATER WORKS COMPANY
Mobile, Alabama

NEW ORLEANS PUBLIC SERVICE, INC.
New Orleans, Louisiana

PUBLIC SERVICE ELECTRIC & GAS COMPANY
Newark, New Jersey

DEPT. OF WATER, GAS & ELECTRICITY
New York, New York

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Philadelphia, Pennsylvania

PHILADELPHIA GAS WORKS CO.
Philadelphia, Pennsylvania

QUEBEC POWER COMPANY, GAS DIVISION
Quebec, Canada

BUREAU OF WATER
Reading, Pennsylvania

DEPT. OF PUBLIC UTILITIES
Richmond, Virginia

WATER & SEWERAGE DEPARTMENT
City of Saint John, N. B.

DEPT. OF PUBLIC UTILITIES, WATER DIVISION
St. Louis, Missouri

THE CONSUMER'S GAS CO. OF TORONTO
Toronto, Ontario

DEPT. OF PUBLIC WORKS
Troy, New York

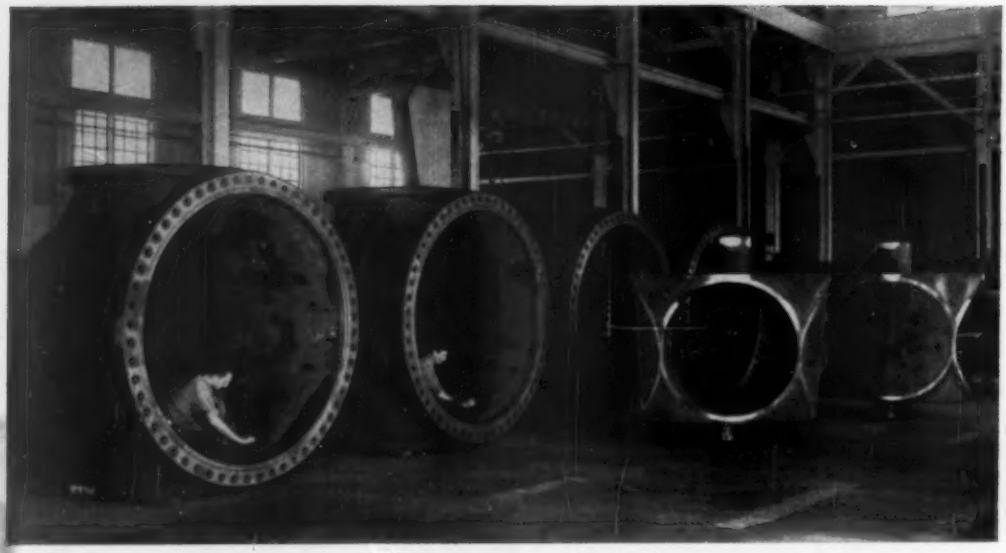
CITY OF UTICA, BOARD OF WATER SUPPLY
Utica, New York

CITY OF WHEELING WATER DEPT.
Wheeling, West Virginia

WILMINGTON WATER DEPT.
Wilmington, Delaware

YORK WATER COMPANY
York, Pennsylvania

SERVES FOR CENTURIES



View of four bodies of 54" ROTOVALVES with two plugs in the background. These valves are part of a large order under construction for the City of New York, Board of Water Supply, Delaware Aqueduct Project.

A Very Real Contribution to Water Works Development!

The ROTOVALVE answers the ever increasing need in the waterworks field for a valve which couples ease of operation with positive performance under both normal and emergency conditions. For these reasons it was selected for both shut-off and throttling services on this important project.

S. MORGAN SMITH Co.

YORK, PENNA. U.S.A.

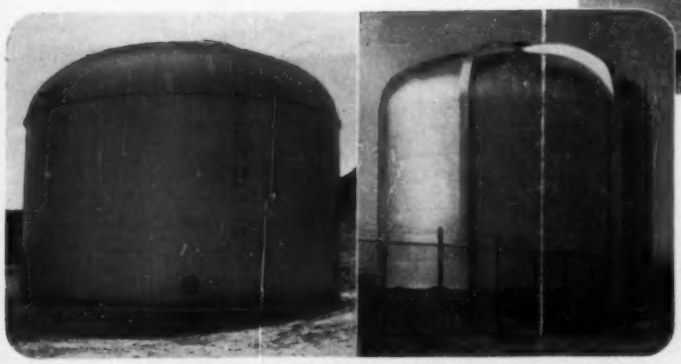
FOR ECONOMICAL

Water Storage

AT NATURAL ELEVATIONS

PITTSBURGH-DES MOINES

Standpipes and Reservoirs



Sound, enduring performance, based on correct engineering, dependable fabrication and careful erection, assures complete satisfaction with Pittsburgh-Des Moines Steel Standpipes and Reservoirs.

Over the years, their first-cost economy, low maintenance, and continued freedom from deterioration make these units an ideal water storage investment. *Write!*

PITTSBURGH • DES MOINES STEEL CO.

Plants at PITTSBURGH, DES MOINES and SANTA CLARA

Sales Offices at:

PITTSBURGH . . . 5418 Neville Island
NEW YORK . . . Room 918, 270 Broadway
CHICAGO, 1222 First National Bank Bldg.
DES MOINES . 918 Tuttle Street
DALLAS . . . 1223 Praetorian Bldg.
SEATTLE . . . 926 Lane Street
SANTA CLARA, CAL. . 625 Alviso Road

YOUR COMMUNITY

needs the safety

and lasting dependability of

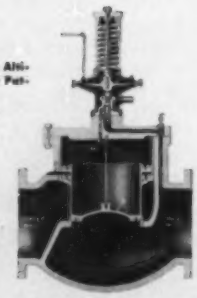
GOLDEN-ANDERSON

positive control **VALVES**

Sensitive Golden-Anderson Altitude Control Valves maintain water levels within 3" to 12" variations, and may be arranged with special equipment to perform a variety of other services.

Inherent water cushioning prevents shock or jar under varying flow conditions. These Valves are easily adjusted for any water level, and include an indicator which shows piston position at all times. Some models actually are two valves in one—a regular automatic Altitude Control Valve as well as a Reverse Flow Check Valve.

Let Golden-Anderson protect life and property through *absolute, safe control* of difficult flow conditions.



G-A Single Acting Altitude Valve, Globe Pattern.

GOLDEN-ANDERSON *Valve* Specialty Co.
Keenan Building, Pittsburgh 22, Pa.

LIFE AND PROPERTY PROTECTION
VALVES SINCE 1905

Less Infiltration

TRANSITE* SEWER PIPE offers two basic safeguards that minimize infiltration in sewer lines: *tighter* joints and *fewer* joints.

Transite's special sleeve-type joints make up tight and stay tight in service.
Its long 13-foot lengths reduce the number of joints in the system.

These safeguards cut down the volume usually allowed for infiltration, reducing sewage load on the treatment plant and conserving plant capacity for future needs. Where new treatment facilities are planned, this reduced infiltration may permit consideration of a smaller plant with resulting economies.

Other Transite Economies—Transite's long lengths help maintain uniform grades; fewer joints reduce turbulence in the line. These advantages, added to Transite's unusually smooth interior, mean better flow qualities (Kutter's n=.010). This often permits designing the system with flatter grades and shallower trenches. Or, as an alternate economy, pipe of smaller diameter may be specified.

Transite Sewer Pipe is made of asbestos, cement and silica by a special manufacturing process that employs steam curing to develop greater corrosion resistance and strength. It is available in four strength classes in sizes to 36", permitting selection of the pipe best suited to trench conditions, and frequently eliminating the need for concrete cradles.

For further details, write Johns-Manville, Box 290, New York 16, N. Y.

*Transite is a Johns-Manville registered trade mark

.....Johns-Manville

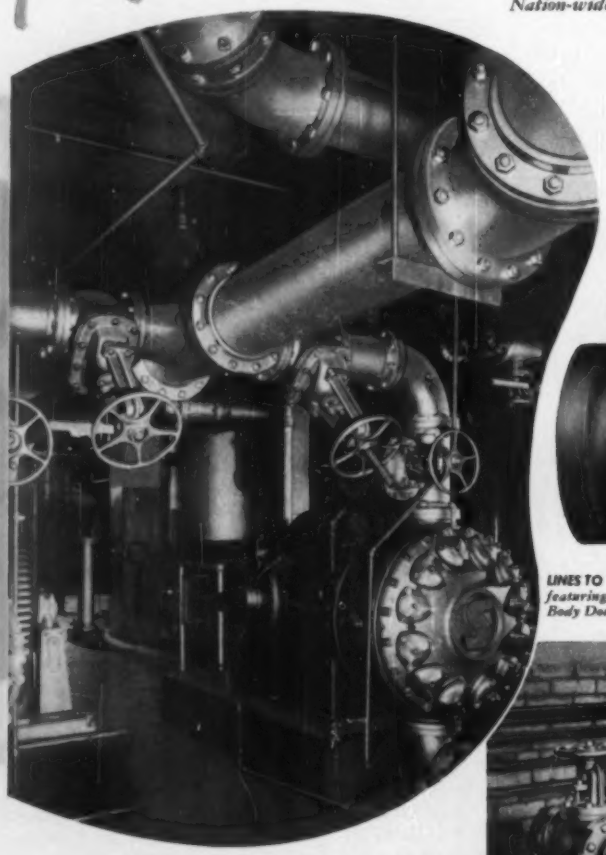
TRANSITE SEWER PIPE...

you rate valves by *performance* too

That's why you find Crane valves rated so highly by men who manage and maintain public water systems. They know that although valves may look alike, it's performance that counts. And that you get dependable performance at low cost when your system is protected by Crane valves.

In fittings as in valves, Crane Quality . . . both in materials and workmanship . . . can play a big part in helping to maintain your utilities at peak efficiency. For today, as always, Crane materials give outstanding service under all operating conditions . . . help to minimize repair and replacement expense.

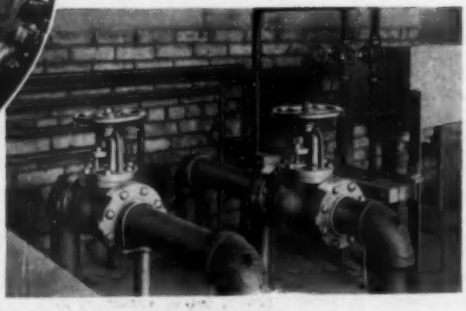
CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Nation-wide Service Through Branches and Wholesalers



AIR LINES IN SEWAGE *and industrial waste disposal plant using Crane 125-pound Iron Body Globe Valves and screwed fittings. One order to Crane covers all piping equipment for installations of this type.*

A.W.W.A. DOUBLE DISC GATE VALVES *by Crane assure complete conformance to latest specifications, offer smooth and positive control for water mains and distribution lines. Shown here, No. 480½ iron body gate with brass trim. Non-rising stem; hub ends. Sizes to 12-in. rated at 200 pounds; sizes 14 to 36-in., at 150 pounds. See your Crane Catalog, p. 126.*

LINES TO VACUUM PUMPS *in disposal plant, featuring Crane 200-pound flanged Iron Body Double Disc Gate Valves and fittings.*



VALVES · FITTINGS · PIPE

CRANE

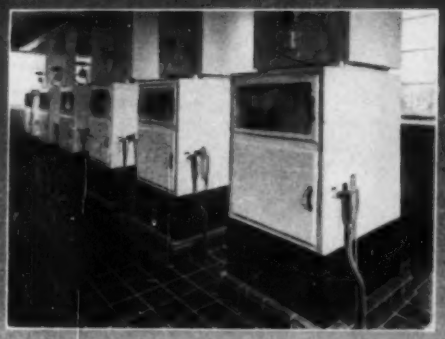
PLUMBING AND HEATING

ORLANDO, FLA.

Filtration Plant

COMPLETED IN 1949

ROBERT AND COMPANY
ASSOCIATES
Architects and Engineers



The City of Orlando, Fla., is solving the taste and turbidity problems of its water supply by a two-step program, the first step of which has been completed with the construction of this new filtration and power plant. Renovation of the old original plant soon will complete the project. Omega Equipment selected for this fine new plant by Robert and Company Associates of Atlanta, Ga., was purchased by the Orlando Utilities Commission and installed by A. H. Guion & Co., Inc. of Charlotte, N. C., to assure clear, palatable water for the 100,000 people of Orange County. For bulletins and engineering data on Omega Feeders, address Omega Machine Co. (Division of Builders Iron Foundry), Providence 1, R. I.

Omega Equipment furnished for the new Orlando Filtration Plant:

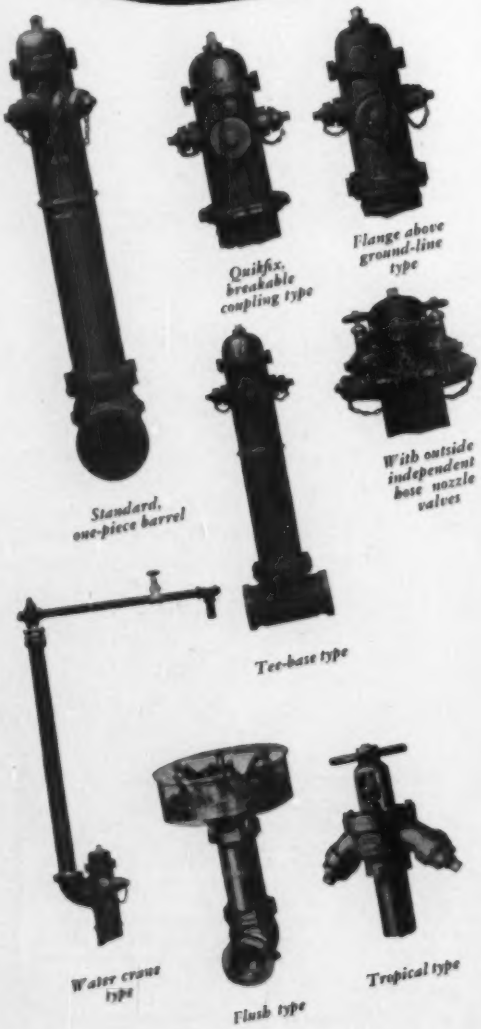
- **6 — OMEGA Model GLW-1 Loss-in-Weight Type Gravimetric Feeders complete with Special Remote Control Panel:**
- **2 — Feeders handle Alum at rates from 5 to 500 lbs. per hr.**
- **3 — Feeders handle Hydrated Lime or Clay at rates from 2½ to 250 lbs. per hr.**
- **1 — Feeder handles Carbon at rates from 2½ to 250 lbs. per hr.**

THE LAST WORD IN FEEDERS
OMEGA

TRADE DARLING MARK

HYDRANTS

...many types and sizes but only one high standard of performance!



YES, there's a Darling hydrant that's just right for practically every known requirement. A few of the different types are shown here. All have one thing in common ... performance at its efficient, low-cost best!

Here's a point to bear in mind. The basic design features that pay off so well in Darling-equipped towns, are applied to all but one of the various Darling types. Many of the working parts are interchangeable . . . planned that way for the sake of user economy, simplified maintenance and low inventory.

Do you have locations where frequent traffic damage is the rule? Are there other places where concealed flush-type hydrants would be ideal? Perhaps there are points where Darling's practical Tee-base type can save you money. And how about future fills and grade changes?

Why not let a Darling engineer explain how effectively, how *economically* your particular service conditions can be met with modern Darling hydrants? Or, if you prefer, we'll gladly send you Catalog 17M. It describes all the various features, types and sizes in complete detail.

TRADE DARLING MARK

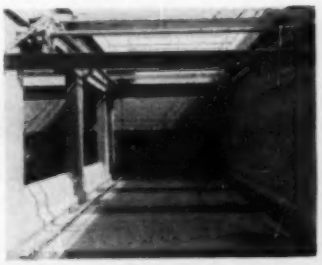
DARLING VALVE & MANUFACTURING CO.

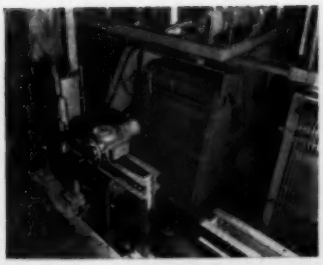
Williamsport 11, Pa.

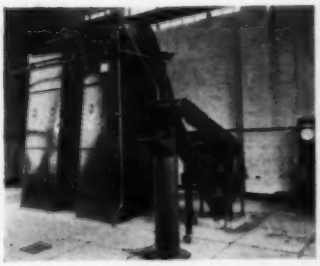
The treatment of water and sewage by mechanical means has definitely proved most effective and economical — is the accepted practice in practically all modern plants. Jeffrey Sanitation Engineers are Specialists — treat each case in a practical way — are qualified by experience to offer technical information on equipment and plant design. Send for list of Jeffrey-equipped plants now giving day-in and day-out service.

a treat to get right treatment

for instance







The five photos show the application of Jeffrey Screens, Collectors, Scum Removers and Grit Washers in both large and small plants. Also Sludge Elevators, Chemical Feeders, Screenings Grinders and equipment for biofiltration plants. Catalog No. 775-A goes into detail.

JEFFREY ESTABLISHED 1877

SALES OFFICES IN PRINCIPAL CITIES

THE JEFFREY MANUFACTURING COMPANY . . 996 NORTH FOURTH STREET, COLUMBUS, OHIO

MORE EFFECTIVE PRIMARY TREATMENT

WITH

P.F.T.

Pre-Aeration

P.F.T. Pre-aeration Equipment at inlet end of primary settling tank, at Stockton Calif., Sewage Treatment Plant. Clyde C. Kennedy, Consulting Engineer.

Pre-aeration and primary settling now can be effectively combined in the primary settling tank by the installation of P.F.T. Pre-aeration Equipment at the inlet end of rectangular tanks.

This equipment consists of standard porous diffuser plates in vertical cast iron holders, arranged for easy removal and servicing of plates. Air introduced to the raw sewage, through these plates, adds oxygen, provides agitation and mixing. This triple action provides three essentials:

1. Elimination of septicity.
2. Conditioning of solids for improved settling.
3. Increased removal of suspended solids and 5-day B.O.D.

A baffle separates the pre-aeration and sedimentation portion of the primary tank. A single sludge removal mechanism can be used to serve both sections of the tank—a further economy.

Installations of P.F.T. Pre-aeration Equipment are giving highly satisfactory performance. Write for further information and list of installations.

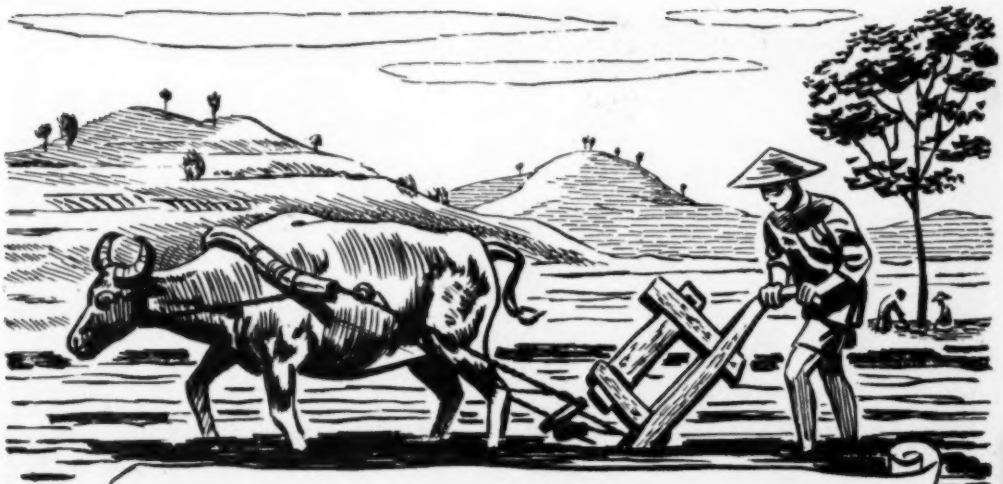
P.F.T.

PACIFIC FLUSH TANK CO.

SEWAGE TREATMENT EQUIPMENT EXCLUSIVELY SINCE 1893

4241 RAVENSWOOD AVENUE CHICAGO 13, ILLINOIS

NEW YORK ● LOS ANGELES ● SAN FRANCISCO ● CHARLOTTE, N. C. ● DENVER ● TORONTO



THE GOOD EARTH

can turn up as a bad taste in your water supply

Don't jeopardize your hard earned consumer good-will by letting vile tastes and odors slip into your water supply. You should anticipate these sudden taste and odor outbursts by stocking an adequate supply of Aqua Nuchar Activated Carbon. Then, by frequently conducted Threshold Odor Tests you can determine the exact quantity of Aqua Nuchar necessary to remove the objectionable taste or odor.

The Threshold Odor Test supplies a relatively simple means of measuring odor intensities in water. With this test, it is possible to determine the quantity and the quality of activated carbon which will be most effective for removing unwanted tastes and odors from any individual water supply.

Water works officials are invited to write to our nearest sales office for complete information regarding the Threshold Odor Test. Water purification experts from our Technical Service Department are available to study your taste and odor problems without cost or obligation.

INSURES PALATABLE NUCHAR DRINKING WATER

industrial CHEMICAL SALES

division west virginia pulp and paper company

NEW YORK CENTRAL BLDG.	PURE OIL BLDG.	PUBLIC LEDGER BLDG.	LEADER BLDG.
230 PARK AVENUE	35 E. WACKER DRIVE	INDEPENDENCE SQUARE	526 SUPERIOR AVE., N.W.
NEW YORK 17, N. Y.	CHICAGO 1, ILLINOIS	PHILADELPHIA 6, PA.	CLEVELAND 14, OHIO

OTHER PRODUCTS: *Snow Top Precipitated Calcium Carbonate • Nuchar Activated Carbons • Liqro Crude Tall Oil • Indusoil Distilled Tall Oil Tallene Tall Oil Pitch • Tallex Abietic Acid • Sulfate Wood Turpentine • Alpha Pinene • Beta Pinene • Polycel Cellulose Fibers • Indulin (lignin)*

Above: general view of pipe casting yard. Below: pipe being unloaded at job site. Left: lowering six-ft. section of 120-in. concrete pipe sewer into a 30-ft. open trench.

Midland, Mich., solves storm drainage problem with 120-in. *CONCRETE PIPE*

DURING RAINY seasons Midland, Mich., suffered from acute surface flooding conditions. To end this nuisance residents voted a bond issue for the installation of an extensive storm sewer system.

This storm sewer required 5,080 ft. of 120-in. concrete pipe for the main outfall section and 30,853 ft. of 12-in. to 84-in. concrete pipe for the storm water collecting mains. The 120-in. pipe was cast in six-foot sections each weighing more than 14 tons. This giant pipe was placed in open cuts often 30 feet deep.

Use of large-diameter concrete pipe like this is economical because it is practical to erect a temporary pipe-making plant near the project. Such job-site production: (1) Reduces transportation and handling costs. (2) Eliminates construction shutdowns that result when pipe shipments are delayed in transit.

Like Midland, hundreds of other cities are using concrete pipe for sewers of all kinds because:

- Concrete pipe sewer lines have the strength to resist severe impact and to sustain heavy overburdens to which they may be subjected.
- Concrete pipe's smooth interior finish resists abrasion and provides maximum hydraulic capacity year after year.
- Concrete pipe is moderate in first cost, has the durability to render long years of service with little upkeep expense. These advantages result in true ***low-annual-cost*** sewer service.

PORTLAND CEMENT ASSOCIATION

33 WEST GRAND AVENUE, CHICAGO 10, ILLINOIS

A national organization to improve and extend the uses of portland cement and concrete, through scientific research and engineering field work

SELECTED IN
1944
BECAUSE OF
Reliability and Efficiency
and
STILL PROVING IT IN
1950

DECATUR, ILLINOIS chose ACCELATORS in 1944 for their water treating plant . . installed to help serve war industries. ACCELATOR was selected because of its *remarkable performance record in over 1100 installations from coast to coast* which treat ONE BILLION *Gallons of water every day!* Simplicity of design, sturdy construction, so few movable and mechanical parts, were added considerations that won Decatur's approval. Today, *in 1950,* its reliability and operating efficiency is still being proven day after day!

Pictured below is the Decatur installation, consisting of 2 ACCELATORS, each 54 feet in diameter. Together, they can economically soften and clarify 12 MGD. Lake Decatur water is treated . . the Lake formed by damming the Sangamon River. Turbidity after treatment averages 2.0 PPM, usually less!

If treating water or waste is a subject of interest to you, by all means send for our new 28-page bulletin No. 1825. Learn how ACCELATOR can . . 1. Save up to 80% in space, 2. Give simpler operation, 3. Faster chemical reaction, 4. Higher ratings, 5. An exclusive slurry recirculating feature which produces better, clearer water in less time. Let our competent engineers help you with your problems. No obligation. Write today.

ACCELATOR®

INFILCO

BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894

INFILCO INC.

GENERAL OFFICES: 325 WEST 25th PLACE • CHICAGO 16, ILLINOIS
SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

Built to stay young

This water line has the give-and-take that pipe lines need for a long, useful life underground. The long lengths of strong, shatterproof steel pipe are cushioned at every joint by flexible Dresser Couplings which harmlessly absorb the punishing stresses of underground service.

And, in the way of carrying capacity, a Dresser-Coupled steel line gives you the *full* advantage of modern, glass-smooth linings. Dressers fit outside the pipe. There is no heat to damage the lining—no need for workmen to go inside the pipe.

A Dresser-Coupled steel line makes for speedy installation, too. You use plain-end pipe in standard lengths. Work proceeds rapidly because the factory-made, factory-tested couplings are easy to install—even in wet or crowded ditches. Any workman who can use a wrench can make permanently tight, flexible joints *every time.*

For an extra margin of safety, permanence and easy installation, specify a Dresser-Coupled steel line. *Write for Dresser's new "Report of Coupled Steel Water Lines".*

SIMPLE • FAST • FLEXIBLE • PERMANENT

Even in cramped quarters encountered in city work, Dresser Style 38 Couplings make permanently tight, flexible joints every time.

PARTIAL LIST OF CITIES USING DRESSER-COUPLED STEEL LINES

Cleveland, Ohio	Boston, Mass.	Newark, N. J.
Philadelphia, Pa.	Syracuse, N.Y.	Savannah, Ga.
Detroit, Mich.	Washington, D.C.	Denver, Colo.
Springfield, Mass.	Spokane, Wash.	New York, N.Y.

DRESSER "FLEXIBLE-TIGHT" **COUPLINGS**

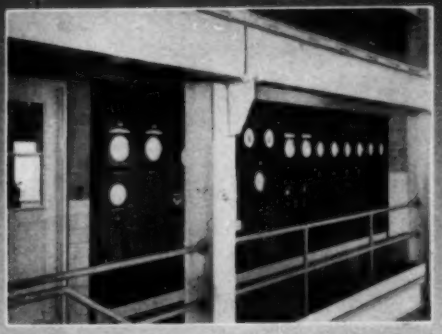
Dresser Manufacturing Division, 59 Fisher Ave., Bradford, Pa. (One of the Dresser Industries)—In Texas: 1121 Rothwell St., Houston—In Canada: Dresser Mfg. Co., Ltd., 629 Adelaide St., W., Toronto, Ont.—Sales Offices: New York, Chicago, Houston, San Francisco.

ORLANDO, FLA.

Filtration Plant

(COMPLETED IN 1949)

ROBERT AND COMPANY
ASSOCIATES
Architects and Engineers



This new filtration and power plant represents the initial step in a modernization program to assure clear, palatable water to people in the greater Orlando area. As a secondary project, the old *original* plant is to be entirely renovated, completing the program. Robert and Company Associates, of Atlanta, Ga., selected the Builders-Providence Equipment for the new plant, and it was purchased by the Orlando Utilities Commission. The building contractor was Ivy H. Smith Co. of Jacksonville, Fla.; A. H. Guion & Co., Inc., of Charlotte, N. C. were the mechanical contractors. For Bulletins describing Builders water works equipment, address Builders-Providence, Inc. (Division of Builders Iron Foundry), Providence 1, R. I.

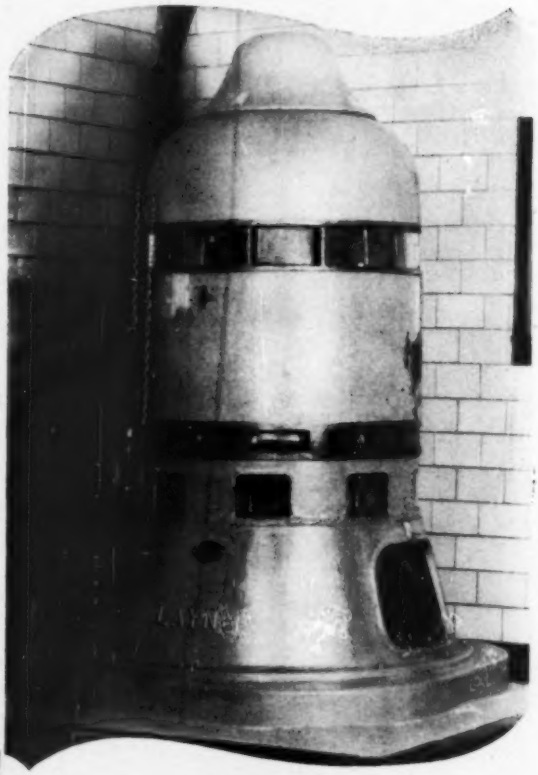
Builders-Providence equipment furnished for the new Orlando Filtration Plant:

- 1 – 30" Venturi Tube with Chronoflo Totalizer-Indicator-Recorder for Raw Water
- 4 – 14" Model RCE Filter Effluent Controllers
- 4 – Model GA2-R Loss and Rate Recording Filter Gauges
- 1 – 24" Orifice Meter with Chronoflo Totalizer-Indicator-Recorder for Wash Water
- 1 – 24" Illuminated Wash Rate Indicator
- 2 – 24" Venturi Tubes with Chronoflo Indicators
- 1 – Chronoflo Recorder for water level
- 1 – Panel Board with misc. gauges and controls

BUILDERS PROVIDENCE
Instruments

What's the value of

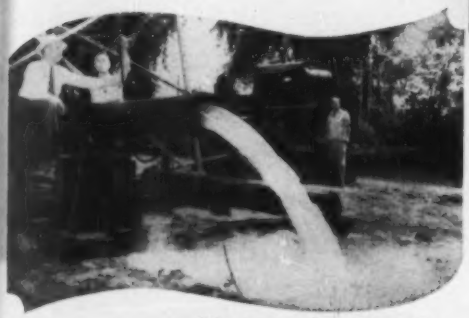
HIGH PRECISION IN MANUFACTURE



"BETTER BUILT —FOR BETTER SERVICE"

Precision is a mighty important requirement by the entire Layne organization. It has always been so. It is the only feature that can adequately support skilful engineering and top quality materials. You can check the results of high precision in every Layne installation. You will notice that they are smoother in operation, produce greater quantities of water and have the lowest figures in upkeep expense.

All well water systems for commercial use are complicated underground construction projects that require more than just ordinary skill. Fortunately, Layne has an abundance of the real "know how" that came from years and years of world wide experience. This means that when Layne plans a well water system, drills the wells and furnishes the pumps, you are going to get a thoroughly dependable and tip top quality job that will give years of fine service.



Old, worn out and costly to operate pumps should be replaced with Layne Verticals. Sizes are from 40 to 16,000 gallons per minute. Write for Pump Catalog.

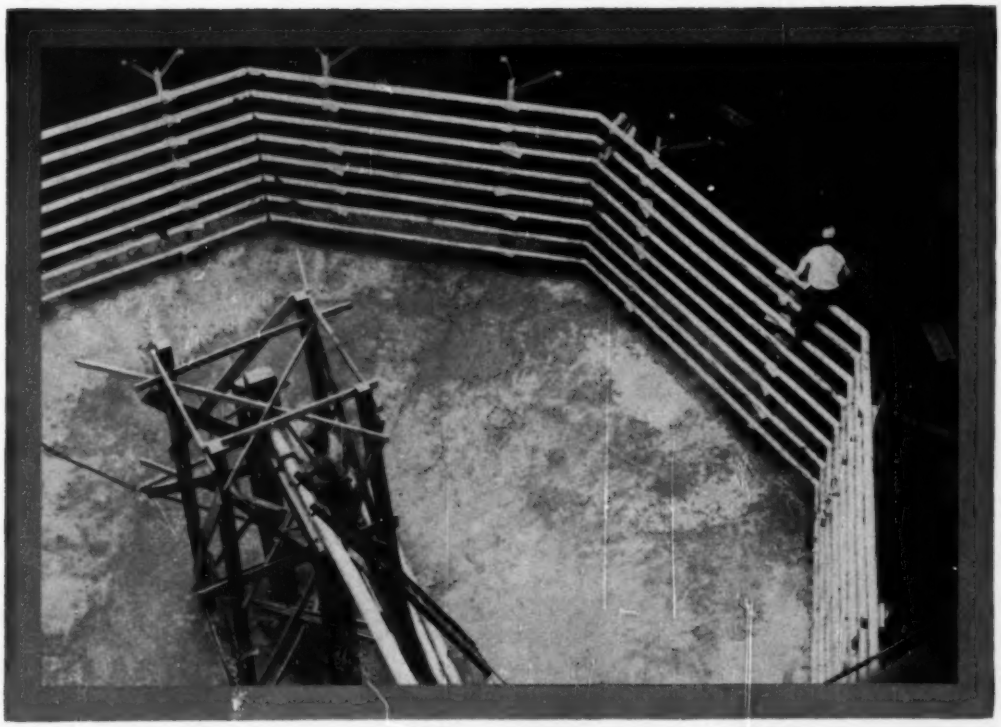
If your plans call for more water in 1950, why not call in Layne first. You will obtain the value of their years of experience, the advantages of their proved "know how" and the satisfaction of dealing with a firm of long established high reputation. For literature, catalogs or any special information, address LAYNE & BOWLER, INC., General Offices, Memphis 8, Tenn.

LAYNE

BUILDERS OF HIGH EFFICIENCY

WELL WATER SYSTEMS

ASSOCIATED COMPANIES—Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ The Layne-Texas Co. Ltd., Houston, Tex. ★ Layne-Western Co., Kansas City, Mo. ★ Layne Minnesota Co., Minneapolis, Minn. ★ International Water Corp., Pittsburgh, Pa. ★ International Water Supply, Ltd., London, Ont. ★ Layne-Hispano Americana, S.A., Mexico, D. F. ★ General Filter Company, Ames, Iowa.



Corrosion Fenced Out Here with Byers Wrought Iron heating coils

There is probably no service in the average sewage treatment plant where corrosive conditions are more severe, and where repairs are more difficult and expensive, than in the heating coils of digestion tanks. To safeguard the installation in the new facilities at Taunton, Massachusetts, the engineers—Fay, Spofford and Thorndike—specified wrought iron. Eight lines of 4-inch extra heavy Byers Wrought Iron galvanized pipe were installed by Hart Engineering, the mechanical sub-contractors and fabricators. Wrought iron pipe was also utilized for all gas piping, except in the operating building.

The selection of wrought iron for both these services follows accepted design practice, and is endorsed by performance records that testify to the superior durability of this time-tried material.

This durability comes, of course, from the unique structure and composition of wrought iron. Tiny fibers of glass-like silicate slag, threaded through the body of high-purity iron, halt and disperse corrosive attack. This discourages the pitting and rapid penetration that causes ordinary materials to fail prematurely. In addition, the fibers anchor the initial protective scale, which shields the underlying metal.

A number of applications of wrought iron, in digester coils and in many other treatment plant services, are illustrated and described in our bulletin WROUGHT IRON FOR SEWAGE TREATMENT AND DISPOSAL INSTALLATIONS. You will find this publication helpful when designing and constructing a new plant, or when repairing an existing plant. We will be very glad to send you a copy.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, Salt Lake City, San Francisco. Export Division: New York, N. Y.

CORROSION COSTS YOU MORE THAN WROUGHT IRON

PRECISION CONTROL

WITH

% PROPORTIONEERS %

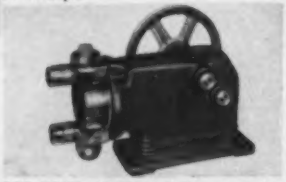
Positive Displacement Proportioning Pumps

Diatomaceous Earth Filters

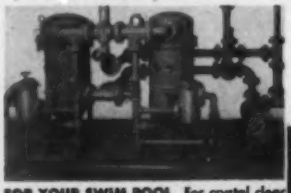
pH CONTROL
COAGULATION CONTROL
FILTRATION CONTROL
CORROSION CONTROL
ALGAE CONTROL
DECHLORINATION CONTROL
TASTE AND ODOR CONTROL
TOOTH DECAY CONTROL
ZEOLITE GENERATION CONTROL
BACTERIA CONTROL
RUST CONTROL
SEWAGE TREATMENT

FOR PUMPED WATER SYSTEMS Constant Rate Feeder — Heavy Duty Midget Chem-O-Feeder. Feeds 0-7½ GPH at 0 to 85 p.s.i.

FOR VARIABLE FLOW SYSTEMS Flow Proportional Feeder — Automatic and Proportional Chem-O-Feeder. Feeds 0-5 GPH at 4-100 p.s.i.



FOR YOUR CAMP Du-Self — a complete Package Unit—for water treating. For flows up to 3 GPM and 75 p.s.i.



FOR YOUR SWIM POOL For crystal clear swim pool water — Pur-O-Cel Diatomaceous Earth Filter, Duplex Model.

NEW IMPROVED CHEM-O-FEEDER

MODEL 1-47

This new Heavy Duty Chem-O-Feeder has many added features for precision control and easier maintenance. Stroke length is instantly adjustable by turning a knob while pump is operating — a magnifying register glass shows exact reading in thousandths of an inch over a range from 2 to 13 cc per stroke. The new Model 1-47 has convenient oil fill and handy sight gauge — all moving parts operate in an oil bath. Plastic "See-thru" reagent head handles any chemical used in the water works field. Available in simplex, duplex and triplex models. Bulletin SAN-7.

With %Proportioneers% Equipment you can always maintain precision control in water purification and sewage treatment. Ask us for recommendations and quotations. Our experience from over 27,000 installations is at your service.

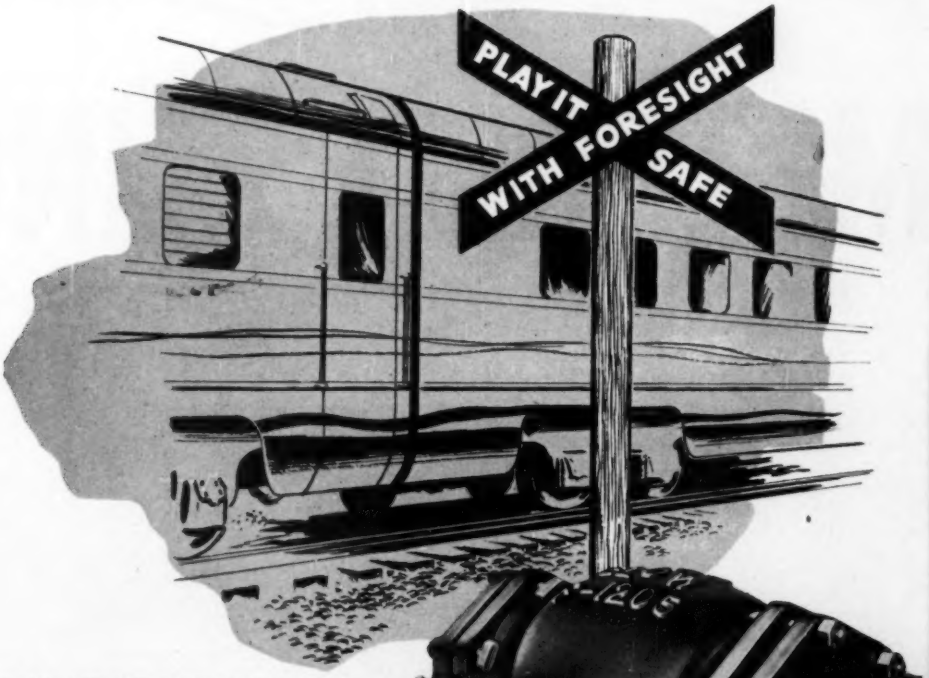
Write for Bulletins.

% PROPORTIONEERS, INC. %

Providence 1, R. I.

Where the pressure's on – reinforce and protect all joints of cast iron pipe with

CLOW BELL SPLIT SLEEVES

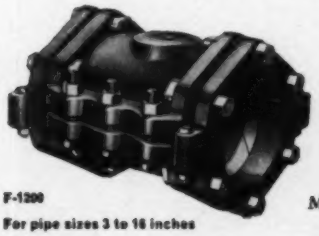


Today Municipal Water Departments all over the country realize the value of playing it safe with CLOW MECHANICAL JOINT BELL SPLIT SLEEVES. In fact, the use for the F-1205 Bell Split Sleeves has become "standard practice" for reinforcing and safeguarding the joints of cast iron pipe where pipe lines pass under railroad tracks or highway truck routes, through marshland or under water, and any locations of piping not easily accessible in case of emergency.

F-1205
For pipe sizes 3 to 16 inches

No Lead . . . No Jute . . . No Calking

Write for completely illustrated descriptive circular

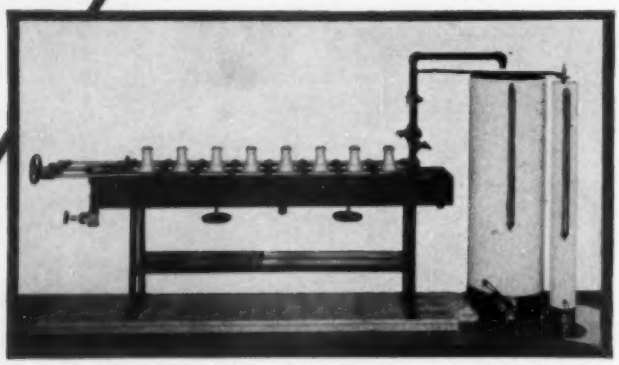


F-1200
For pipe sizes 3 to 16 inches

JAMES B. CLOW & SONS
201-299 North Talman Avenue • Chicago 80, Illinois
and their National Cast Iron Pipe Division, Birmingham, Ala.; subsidiaries Eddy Valve Co., Waterford, N. Y.; Iowa Valve Co., Oskaloosa, Ia.

Make repairs to pipe barrel with F-1200 Clow Mechanical Joint Straight Split Sleeves. Sizes 12-inch and smaller will repair length-wise breaks up to 8 inches; sizes 14-inch and 16-inch, up to 17 inches.

More Revenue through Better METER TESTING



"REGULAR and periodic testing and repair of meters should be so scheduled as to produce maximum net revenue. Changing the specifications for meter testing *from* registration through fixed diameter orifices *to* rates of flow in gallons per minute has been found to increase overall registration, with a corresponding increase in revenue far beyond the entire cost in both equipment, material and labor."

Statement by the Manager of the Water Department of a large Eastern City.

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WATER & SEWAGE WORKS

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DEVELOPMENTS IN THE WATER WORKS FIELD DURING 1949

by

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THE year 1949 has been characterized by a substantial increase in the construction of new water works facilities. This has resulted in part from the necessity of undertaking long-deferred maintenance work, and in part from new additions to water plants and distribution systems to meet the greatly increased demands of the post-war years. How best to prepare for and carry out such programs was the keynote of a conference held by the Water Utilities Division of the National Resources Security Board in Washington in January, 1949. It was attended by some forty water supply executives and manufacturers selected on the basis of geographical representation of the industry. It seemed to be the consensus of opinion that, while construction costs remain high, the hazards involved by further postponement of deferred maintenance and necessary additions are such that at least the most urgently needed projects should be undertaken.

The Author

Construction Cost

While there are indications that 1948 witnessed the turning point in the post-war construction price rise, construction costs still remain high. Although the *Engineering News-Record* cost index (1913 = 100) for 1948 was 460.7, the peak of that year was reached with an October index of 480.2. By February of 1949 the index had dropped to 475.4, but by October of 1949 it had risen to 480.54, or slightly above the corresponding figure for October, 1948.

In spite of these high construction costs, a spot survey (*Water Works Engineering*, September, 1949) of the estimated cost of water works improvements and extensions for 1949 and 1950 indicated a rather surprising increase in the volume of anticipated construction. This survey, made in July, 1949, included 12 of the 16 U.S. cities having a population of over 500,000, a total of 72 cities well-grouped according to size, and represented a population of approximately 30,000,000 persons. The survey showed an estimated per capita expenditure for water works construction of $4.31 for 1949 and $5.62 for 1950. Based upon these figures, the overall estimated construction cost of water works facilities for 1949 was $357,000,000, and for 1950, $432,000,000. Since the ENR dollar volume of water works construction for 1948 was only $191,648,000, it seems evident that even if the estimates are not completely accurate a substantial increase in water works construction is in prospect.

New Plants and Systems

The new $600,000 ozonation plant of the City of Philadelphia was placed into operation in March, 1949. The plant consists of 50 ozone generators, each capable of producing 25 pounds of ozone per 24 hours, or a total capacity of 1250 pounds per day. Since the ozone is delivered at a concentration of between 0.5-1.0 per cent by volume, this means that the total air circulating through the generators will vary from 1,500,000 to 3,000,000 cubic feet per day.

Notable progress is being made on New York's great Delaware Water System, the total cost of which is now estimated to be $440,000,000. Nearly three-quarters of this work, which will supply 540 mgd. of additional water, has already been put under construction. One of the most interesting features of the project will be the installation of water turbines to pump Croton water into the new aqueduct, utilizing the available head at and Croton Dams. Contract for this

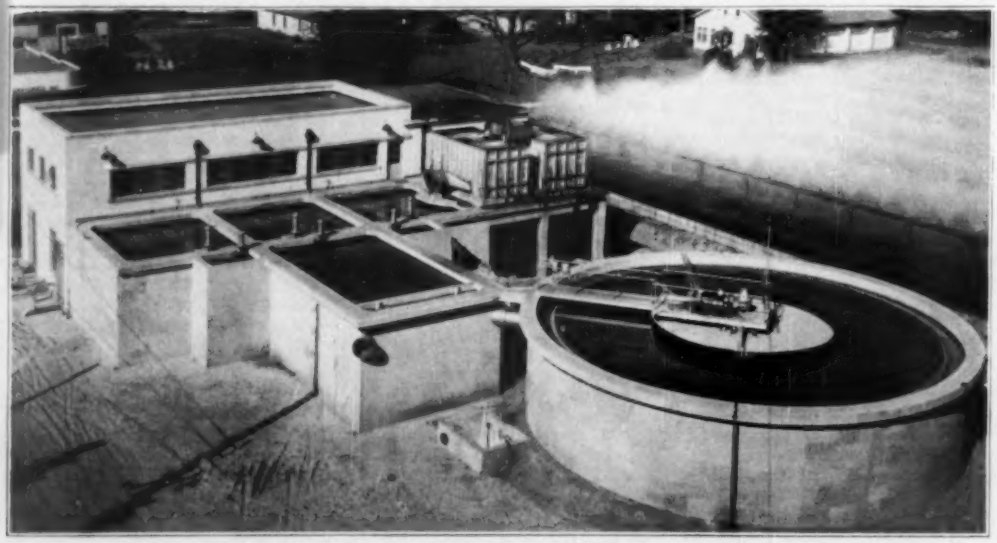
Miami, Fla., 80-Ton Per Day Lime Recovery Plant
(First in this county; it will save $100,000 a year)

station to cost $963,600 was let in February, 1949.

The new $4,000,000 unit of the LaVerne Water Softening Plant, of the Metropolitan Water Dist. of Southern Calif. was dedicated in August, 1949. The new unit which, like the initial unit, consists of softening with lime and zeolite, increases the plant capacity to 200 mgd. The ultimate design capacity of the plant when completed is 400 mgd.

June, 1949, witnessed the completion of the first of the new two-story flocculation and sedimentation basins at the Dalecarlia Treatment Plant, Washington, D.C. Three such basins will ultimately be constructed increasing the nominal capacity of the Dalecarlia Plant to 217 mgd. and the McMillan slow-sand filter plant to 125 mgd. The initial basin whose cost, including some additional items, was $1,109,000, has a total length of 776 feet in the direction of the flow of water, 316 feet in the lower story and 460 feet in the upper story. The lower story has a depth of 17 feet, the upper story a depth of 15 feet and the total width is 138 feet. The capacity of the sedimentation section of the basin is 12,074,000 gal. with a theoretical retention period of 5.4 hours.

Early in 1949 the City of Miami completed additions to the Hialeah Water Treatment Plant, increasing its capacity from 40 mgd. to 60 mgd. and in December, 1949, let contracts for the treatment units of the first half of a new softening plant to have an ultimate capacity of 80 mgd. In addition, the city completed and placed in operation its new lime recovery plant, the first of its type in a water treatment plant in this country, and the second in the world. It is a rotary kiln 7 ft. 7⅛ in. in external diameter and 230 feet long. and has a rated capacity of 80 tons of quicklime per day. Placed in operation in February, it had produced by the end of 1949 approximately 11,000 tons of quicklime containing 92-93 per cent available CaO. Average production is ap-



The New Softening Plant of Gainesville, Fla.
(In Nov. 1949, fluoridation was added)

proximately 50 tons per day and the plant is presently supplying several other Florida cities with their entire lime requirements. It will effect a saving in chemical costs in excess of $100,000 per year. The cost of the new plant, with accessory equipment, was in excess of $700,000.

Also in 1949, Little Rock, Ark., doubled its filter plant capacity to meet rapidly rising water demands.

Looking to the south of us for a moment, it is interesting to note that in January, 1949, Mayor Nicolas Castellanos officially inaugurated the operation of a new 66-inch pipe line to deliver water to the City of Havana, Cuba. This line, constructed at a cost of $3,250,000, constitutes the first step in a projected series of improvements to the Havana Water Works to cost $30,000,000.

The construction of the Rio Grande de Loiza Water Supply Reservoir Filtration Plant and Pipe Line to supply San Juan, Puerto Rico with an adequate and healthful water supply is rapidly nearing completion. The new filtration plant will have a capacity of 30 mgd. and the entire project, including dam, reservoir, treatment plant and transmission lines, will involve an ultimate expenditure of approximately $25,000,000.

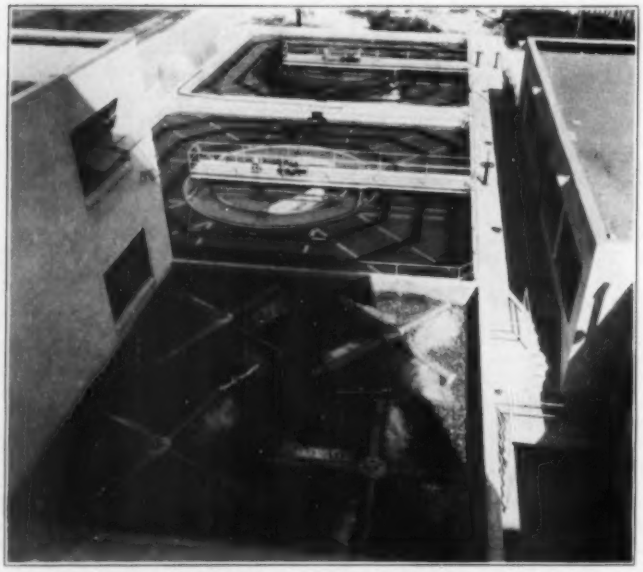
Statistics such as these tend to focus our attention on the tremendous growth which has taken place in the water works industry in the past sixty years. Some exceedingly interesting data are presented in Langbein's recent analysis of the USPHS "Inventory of Water and Sewage Facilities in the U.S., 1945." He shows, for example, that whereas in 1890 there were only 1,878 water works in operation in this country, serving 22,800,000 people, or 36 per cent of the population at that time, there were in 1945 15,400 water works serving 94,390,000, or 71 per cent of the population. The daily estimated usage increased during the period from 2,050 mgd. in 1890 to 12,030 mgd. in 1945. Even more interesting is the fact that the average per capita use of water increased from 90 gpd. in 1890 to 127 in 1945. Further, his survey shows that in cities above 10,000 population this figure is 140 gpd.

A.W.W.A. Growth and Activities

It is a source of very real pride to the officers and members of the American Water Works Association that its growth during this period has paralleled the growth of the water works industry. Whereas the membership of the Association was only 2,547 at the close of 1929 and 3,710 at the close of 1939, it will be observed that the Association has more than doubled its membership in the past decade. (membership for the close of 1949 estimated at 7700). This membership growth was reflected in the registration figure of 1,967 at the Chicago meeting in June, 1949, this figure being 263 over the registration at the Atlantic City meeting in 1948. Section meetings during 1949 have set an exceptionally high standard both in quality of programs presented and in total attendance. In particular, some of the newer sections established as a result of the breakup of older and larger sections are showing unusually rapid growth.

In July of 1949 the *Journal of the Amer. Water Works Assn.* received national recognition when it was awarded the plaque given by *Industrial Marketing*. The plaque awarded annually "For the best original publication, market, or technical research published in a regular issue. Research must be initiated by and financed by

Little Rock, Ark., Increases Filter Plant Capacity from 15 to 23 mgd.



Orlando, Fla. Two Walker Clariflow Units Preceded by Rotary Aerator—16 mgd.

the publication," was awarded the *Journal* for the paper "A Survey of Operating Data for Water Works in 1945," which appeared in the February, 1948, *Journal*.

The Association took another significant step forward when the Board of Directors in January, 1949, approved a pension system for the staff employees of the Association. This pension system, prepared by a special committee of the Board, is believed to be a model of its kind.

One standard and four tentative specifications were published during the year, together with revisions for a sixth. These included "Standard Specifications for Elevated Steel Water Tanks, Standpipes and Reservoirs," "Tentative Standard Specifications for Cold-Water Meters—Current Type Propeller Driven," "Tentative Standard Specifications for Filtering Material," "Tentative Standard Specifications for Reinforced Concrete Water Pipe—Steel Cylinder Type, Prestressed," and "Tentative Standard Specifications for the Installation of Cast-Iron Water Mains." In addition, revisions were made to the "Tentative Recommended Practices for Inspecting, Repairing and Repainting Elevated Steel Water Storage Tanks, Standpipes and Reservoirs," and the "Tentative Manual of Cation Exchanger Test Procedures" was published.

The newly organized Water Resources Division made an auspicious beginning by presenting two strong division programs at the Chicago meeting. The one which appeared to attract the most interest was the open forum on "Ground Water Law—Current Developments" presented by nine speakers and discussed by many others. The Division plans to bring together in a single statement the existing policies of the various state agencies with respect to water law, and to prepare in tabular form a summary showing the differences, State-by-State, in the various facets that are common to many of the existing laws.

Air Conditioning

The report of the Amer. Water Works Assn. Committee on "Regulation of Water Use in Air Conditioning" at the Chicago conference, while presented as a progress report only, makes important additions to available knowledge in this important field. The Committee emphasized the fact that serious legal, technical and political problems are involved and that the quality of the water supply itself is an important consideration. The report presents regulations from a number of localities in the United States which will be found of value to those interested in this subject.

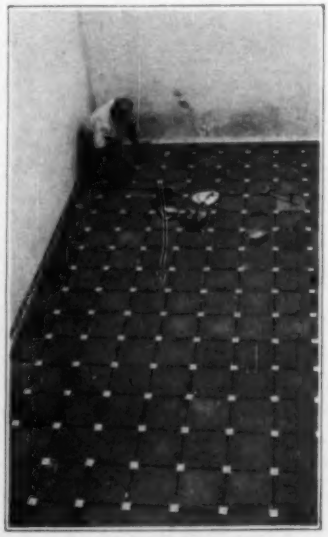
Water Main Extension Policy

This, one of the oldest problems of the water utility, is being competently studied by an Amer. Water Works Assn. committee, and the report at the Chicago conference in June constitutes a valuable addition to existing information. The Committee agreed tentatively upon six principles which should be observed in formulating and administering water main extension policies.

1. Extension policies should be nondiscriminatory.
2. Extension policies should be based upon business principles.
3. Extension policies should assure that main extensions will be self-supporting.
4. Extension policies should provide for customer participation in the financing of extensions into localities within the utility service area where service is needed if the anticipated revenue is insufficient to warrant the utility making the extension unassisted.
5. Extension policies should be implemented by the adoption and promulgation of comprehensive rules.
6. Extension rules should be reviewed periodically.

Water Rates

The necessity for expanded water utilities to meet the greatly increased demands of the post-war years continues to stimulate intense interest in the subject of water rates. Under the sponsorship of the Amer. Society of Civil Engineers there has been formed a "Joint Committee on Fundamental Considerations in Rates and Rate Structure for Water and Sewage Works." The Committee includes representatives from the Amer. Water Works Assn., Amer. Bar Assn.,



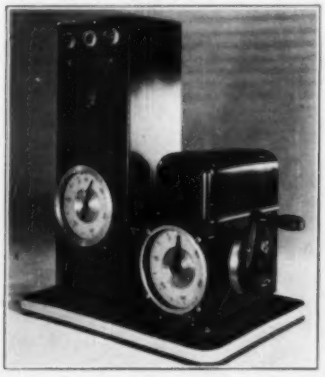
Austin, Tex. Filter with Porous Underdrain

(Completing the porous plate bottom by bolting down plates and pointing up spaces between plates)

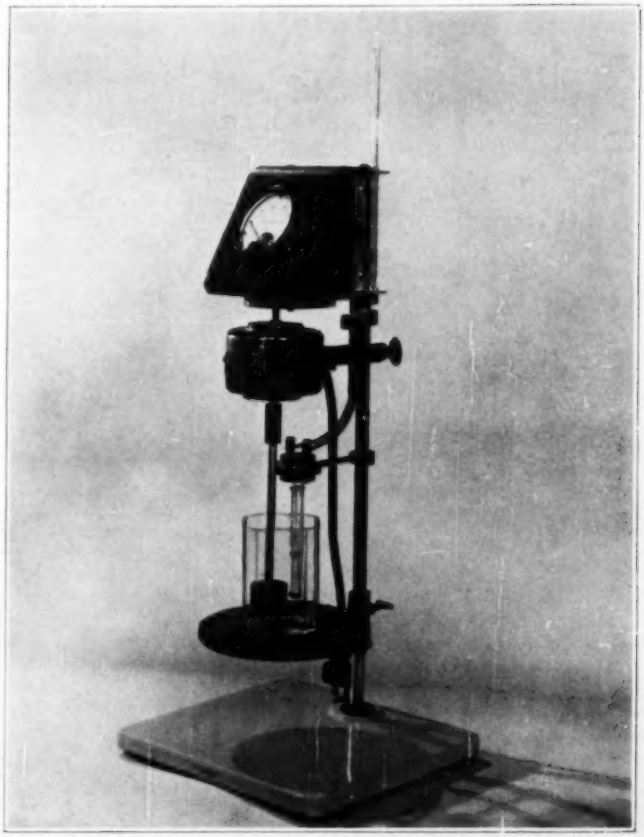
Amer. Public Works Assn., Municipal Finance Officers Assn., Federation of Sewage Works Assns., National Assn. of Railroad and Utilities Commissioners and the Amer. Soc. Civ. Engrs. The Committee proposes to deal with fundamental considerations to the end that some sort of order may evolve from the present state of confusion. The panel discussion of this subject at the Chicago conference was received with great interest.

Stream Pollution

Signing of the Water Pollution Control Act (Public Law 845) in June, 1948, by President Truman was followed by the appointment of a Water Pollution Control Advisory Board, and evidence of increased activity in stream pollution abatement is rapidly mounting. Provisional allotments totaling $850,000 have already been made by the Federal Security Agency for grants, under the terms of the Act, to the various states, territories and the Dist. of Col. for pollution studies. Water pollution control activities will be organized on the basis of major river basins and 14 river basin offices have been set up for this purpose. The City of Cincinnati is planning a $25,000,000 sewage disposal program. New York State's pollution control bill became a law in April, 1949, and 87 New York communities which discharge untreated or partially treated sewage in the state waters take advantage of the planning provisions of the bill. In Pennsylvania the Allegheny County Sanitary Authority is planning one of the largest projects of its kind ever conceived and which, upon completion, will involve a cost of $55,000,000. Agreements for participation in the program and plans have already been made with 59 municipalities and 30 industries.



Permutit's Electro-Chemical Solution Feeder



Simplified Amperometric Titration Apparatus for Control of Chlorination—After Mahan

Fresh Water from Salt

Interest continues to mount in the possibility that sea water may be economically used as a source of fresh water in those areas where fresh water supplies are insufficient to meet the needs of human life, agriculture and industry. This publicity has been given added impetus during the past year by the severe drought conditions which have prevailed in the Pacific Southwest. Bills have been introduced before both the House and the Senate of the Congress to appropriate $50,000,000 to build a full scale experiment still to make fresh water from sea water. Because of the nature of the problem and of the issues involved, it is exceedingly important that a realistic attitude be taken toward this problem and a sound scientific approach made to it.

The nature of the problem is best shown by Aultman's excellent summary. He states that at the present time the cost of untreated water from the Colorado River Aqueduct, including interest and bond redemption, is about $20.00 per acre foot, or 6 cents per 1,000 gallons. Softening and filtering the water brings the total cost of treated water to $30.00 per acre foot, or 9 cents per 1,000 gallons. The unit which appears at the present time to have the geratest possibility is the "Kleinschmidt still" employing multiple-effect evaporation under pressure. Aultman points out that assuming a yield of 200 pounds of water per pound of fuel, the cost to produce water by this method would be $400 to $500 per acre foot delivered, or $1.17 to $1.53 per 1,000 gallons. This is 13 to 17 times the present cost of softened Colorado River water.

The analysis of probable costs to produce fresh water by demineralization, by electrolysis, or by freezing yields figures of the same order of magnitude. Aultman concludes, as a result of his studies, that within the foreseeable future there appears to be

San Juan's 48-in. Loisa Supply Line

no possibility that it will be economically feasible to turn to the ocean as the source of domestic, agricultural, or industrial water along either coast of the United States.

No Polio from Public Water Supplies

Reassurance that there is no evidence of the spread of poliomyelitis by public water supplies was given recently by one of the nation's leading epidemiologists, Kenneth F. Maxcy, M.D., Professor of Epidemiology at Johns Hopkins University. Writing for the *Journal* of the *Amer. Water Works Assn.*, Dr. Maxcy surveyed the results of half a century of epidemiological studies and laboratory experiments by a host of investigators. In not a single one of these investigations was there found convincing evidence that pollution of a community water supply was responsible for exposure of consumers to infection with the polio virus.

What Dr. Maxcy found to be definitely established is the fact that the principal means of communication of polio, not unlike other common contagious diseases, is some form of personal contact, or, as he expressed it, some "intimate personal association . . . realized in communal living of any social group, from the primitive to the most advanced, at any time of year, in any part of the world." And though it logically follows from this that the disease could be spread indirectly by flies, milk or water contaminated with the discharges from infected persons, all attempts to demonstrate the polio virus in suspected drinking water have so far been unsuccessful.

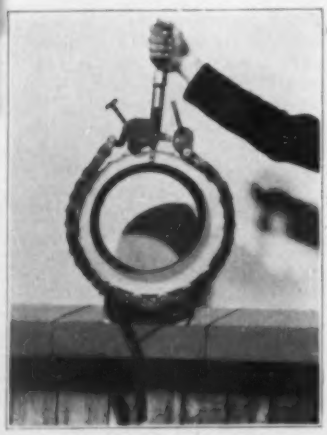
Although he urged a continued investigation of the effect of standard water purification practices on the removal or inactivation of viruses, Dr. Maxcy did not hesitate to state that the present methods of water treatment, and particularly the dosage of free chlorine customarily used in water disinfection, afforded an adequate safeguard. "Present day knowledge," he concluded, does not justify anxiety over the safety of public water supplies so far as the spread of poliomyelitis is concerned."

Fluoridation

The publication by the Amer. Water Works Assn. in July, 1949, of a statement of recommended policy and precedure with respect to the fluoridation of public water supplies has served to materially clarify the situation with respect to this somewhat controversial question.

The statement does three things. In the first place, it distinguished between those "experimental" situations where the fluoride-dental caries hypothesis is being subjected to experimental verification under carefully controlled conditions from those "empirical" situations where communities are willing to provide the cost of fluoridation in order to give anticipated protection to the oncoming generation of children at the earliest possible time. In the second place, it places responsibility for the approval of the procedure in the hands of the local medical and dental societies, and the local and state health authorities. In the third place, it provides a statement of recommended procedure for the guidance of those water departments wishing to initiate the process.

The Association summarizes its policy in the following statement: "In communities where a strong public demand has developed and the procedure has the full approval of the local medical and dental societies, the local and state health authorities, and others responsible for the communal health, water departments or companies may properly participate in a program of fluoridation of public water supplies." In so doing, the Association has taken the attitude that the role of the water works man is that of agent, rather than advocate, of fluoridation. Finally, the statement emphasizes the fact that the cost of treatment, estimated at approximately 10 cents per



H. D. Fowler Asbestos-Cement Pipe Cutter

Warsop Portable Gasoline Pavement Breaker

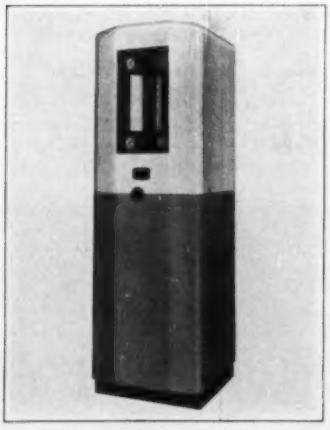
capita per year, should be recognized as a public health expense and thus not chargeable to water utilities.

H. A. Faber, in a survey made in August, 1949, found that at that time 19, or 40 per cent of the states, had adopted a definite policy regarding the fluoridation of public water supplies and 33, or 70 per cent of the states, considered the Amer. Water Works Assn. Statement of Policy acceptable.

At the close of the year a total of 18 fluoridation installations were in operation in the public water supplies of 10 states; each of 8 states has one installation, one state has two installations and one state (Wisconsin) has 8 installations. Twelve of the installations are classified as experimental and six as empirical. A total of three fluoridation installations are in operation, or in the experimental stage, in institutional water supplies of two states.

Latest addition to the list was the City of Gainesville, Fla., where fluoridation was begun in November, 1949. During the same month a proposal that the City of Austin, Texas, fluoridate its municipal supply was unanimously endorsed by both the Travis County Dental and Medical Societies and has been approved by the State Dept. of Health.

At Charlotte, No. Car., where fluoridation was begun in April, 1949, it has been reported that the procedure has resulted in a severe increase in brittle and cracked ice in the local ice plants. The matter is being carefully investigated at the present time. A considerable number of cities scattered throughout the country are planning to begin fluoridation during 1950.



Builders—Providence Chlorinizer
(Also available as a gravimetric feeder)

Closeup of Electrode for Lining Pipe by The Pittsburgh-Erie Process

Work now in progress indicates the possibility that sodium fluo-silicate may be substitute for sodium fluoride with a resulting saving in the cost of the process.

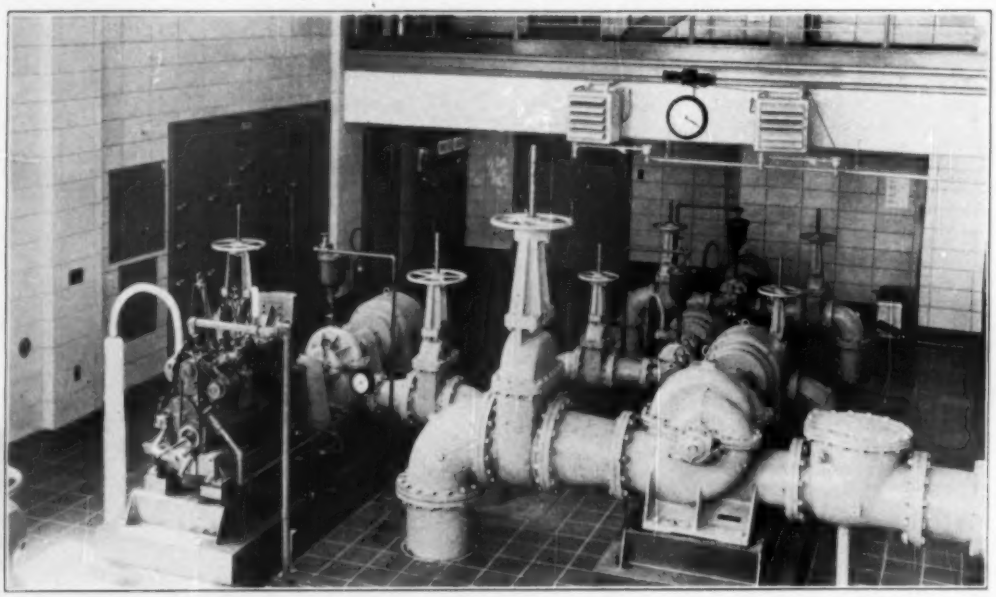
Chlorination

Considerable progress was made during the year both in treatment processes and in laboratory methods for their control. It is becoming clear that the bactericidal effect of applied chlorine is in direct ratio to the amount of free hypochlorous acid present in the water. This serves to explain the lower efficiency of chlorine at high pH values since it has been shown that below pH 6.5 chlorine is present entirely as hypochlorous acid, above pH 9.5 as hypochorite ion, and between these two pH values there is an equilibrium between the two forms, the relative amount of each being dependent upon the pH value.

It is interesting to note that it has been found that dosages of activated carbon up to 20 pounds per million gallons have little or no effect in reducing the free residual chlorine content of water. Interesting also is the observation that nitrogen trichloride may be destroyed by ammonia quite rapidly at pH values above 8.0 and somewhat more slowly at lower pH values. This observation may be of importance in those plants where free residual chlorination is being employed.

In February of 1949 the City of Miami, Fla., inaugurated free residual chlorination in its 60 mgd. Hialeah plant for the removal of organic color. A dosage of 9 ppm. of chlorine provides a free residual and lowers the organic color to approximately 5. Pilot plant tests indicated this to be the most economical method of removing organic color and the tests have been completely verified by sev-

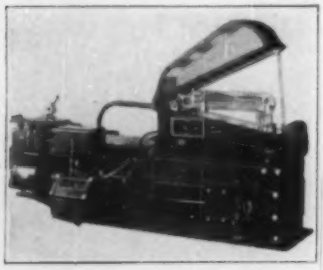
Wachs National Pipe Saw



Port Washington, Wis.—General View of Pump Room Showing Westinghouse Control

(Switch Gear is under the balcony)

eral months of full scale plant operation. The City of Indianapolis, Ind., continues to employ free residual chlorination successfully at both the Fall Creek Treatment Plant and the White River Plant. Average dosage of chlorine at Fall Creek is 3.6 ppm. and at White River, 5.9 ppm. Three times as much chlorine is used in these plants as would be used if a combined chlorine residual of the same value were maintained in the treated water. However, six years of operation with free residual chlorination have indicated substantial savings in coagulant costs, better control of tastes and odors, and prevention of slime growths and biologic deposits on filter sand and gravel.



The W & T Marchen Scale Feeder

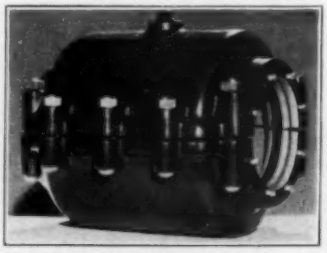
Chlorine Dioxide

Chlorine dioxide has received increasing attention during the year and has been employed for a variety of purposes. Originally suggested to destroy phenolic compounds and prevent the formation of chlorophenol tastes and odors, it is being increasingly used for the prevention or destruction of other types of tastes and odors, for the maintenance of stable chlorine residuals throughout distribution systems, and for its bactericidal and sporocidal effects. Studies published during 1949 indicated quite definitely that whereas the bactericidal efficiency of chlorine decreases with increasing pH values, the bactericidal efficiency of chlorine dioxide increases with increasing pH values. Furthermore, it has been found that chlorine dioxide is a more effective sporocide than is chlorine, if compared on an equal OTA residual basis. In other words, the effectiveness of the OTA residual from chlorine dioxide, as related to chlorine, seems to be greater on spores than on vegetative cells. These interesting and important findings with respect to the effectiveness of chlorine dioxide would appear to indicate increased use for the chemical as time passes.

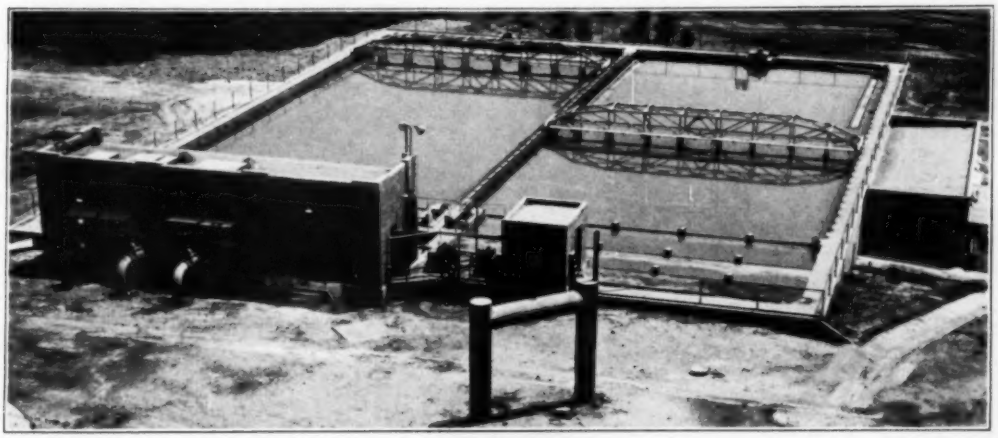
Work done during the year indicates that the use of hydrochloric acid as the acidifying agent in the OTA test gives measurable interference of chloramines in the test for free chlorine. The interference can be lessened by using a minimum amount of the orthotolidine reagent and by adding the arsenite as soon as possible after the sample and the orthotolidine reagent are mixed. Correction factors which allow the determination of the true free chlorine concentration from results obtained by the OTA test have been worked out and by means of these correction factors the tests may be employed for estimating free chlorine at temperatures as high as 35°C.

Versene Reagent for Hardness

More than a little interest is being shown in the Schwarzenbach titration of total hardness in water by the use of versene reagent. "Versene" is the



Dresser Bell-Pack Repair Sleeve



Dorr Co. Monorake Installation at Macon Kraft Co., Macon, Ga.
(The paper industry requires water free of turbidity and color)

registered trademark of certain synthetically prepared polyamino acids and their salts. The best known of these is the tetrasodium salt of ethylene diamine tetra acetic acid. This compound has the remarkable property of forming various stable complexes with many metals, including calcium and magnesium. These complexes are, for the most part, water soluble and are known as chelates. In the case of the hardness titration, a dye is added which forms a wine red complex with magnesium. As the standardized versene reagent is added to the hard water, it first chelates with the calcium ions and then with the magnesium ions. The versene chelate being more stable than the wine red dye complex, the magnesium is removed from the complex and the end point is indicated by the appearance of the deep blue color of the original dye.

Work done during 1949, and as yet unpublished, indicates that a number of commercially available dyes other than that first suggested, may be used for the titration. Further unpublished work has also indicated at least two modifications whereby both calcium and magnesium may be directly determined by this titration. Both copper and manganese interfere with the titration and suitable modifications must be made if either or both are present. Carefully performed, the accuracy is comparable with the results obtained by the use of gravimetric analysis. These versenes appear to have interesting and important applications to water treatment. They sequester heavy metals present in water without the formation of precipitants and, more important, they have the property of dissolving scale deposits in place. Their use in removing certain tightly-held metal ions from cation-exchange resins has been suggested.

Ion-Exchange

Increased attention has been focused during the year on the applications of the non-phenolic cation-exchangers in water softening. In the LaVerne Plant of the Metropolitan Water Dist. of Southern Calif., it has been found that they are able to operate at an exchange capacity of 20,000 grains per cubic foot at a salt efficiency of 0.25 pounds per kilograin of hardness removed without any apparent deleterious effect. Under these conditions it is further stated that a minimum useful life of 3,000,000 gal. per cubic foot may be expected from these materials. Important also in the application to both municipal and industrial uses is the fact that they appear to be almost completely resistant to very high concentrations of both acid and alkali. For example, it has been found that after 30 days' continued exposure to 8 per cent sodium hydrogen solution at 150°F., no physical or chemical depreciation or loss of exchange capacity could be observed. They may also be used at temperatures above the boiling point of water. They are not affected by either chlorine or hydrogen sulfide and they may be operated at amazingly high rates of flow.

Equipment News

There was little real new equipment for the water works field developed in 1949. There were, however, many new models or improvements in old models of a wide variety of auxiliary equipment. New protective coatings, and cathodic protection devices kept pace with the interest in anti-corrosion measures. Motor manufacturers brought out several variations in design of pump motors; instruments for the control of operations were redesigned or otherwise improved, and two manufacturers of chlorine brought out Safety Wall Charts.

Builders-Providence, Inc. and Fischer and Porter entered the field of chlorinator manufacture, the former with two volumetric feed units and one gravimetric feed unit. There were also two smaller units, the Paulsen Chlorameter, and the Paddock Engr. Co. Chlorimator.

Wallace and Tiernan brought out a dry chemical feeder and improved solution chemical feeders were developed my Phipps & Bird Permutit. Two new types of paving breakers were introduced, the Homelite powered by electricity, and the Warsop, a portable gasoline unit. Of interest to the laboratory man were the new analytical balance and the new unitized test benches and laboratory furniture developed by Fisher Scientific Co.

Three unique and entirely new developments included the Nordstrom Valve "Hypermatic" lubrication system for plug valves, the H. D. Fowler asbestos cement pipe cutter, and the Wachs National Pipe Cutting Machine.

Among the other interesting developments were the Dresser Bell Repair Sleeve, a hydrant marker, and an earth boring machine.

WATER TREATING EXPERIENCES

The First of a Series of Articles

by

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IN a series of articles, of which this is the first, the author will attempt to describe his experiences and observations in treating medium soft water, very soft water, and in softening a relatively hard water.

It is our opinion that the Water Purification Engineer should evaluate his source of supply and then fashion a treatment for it which will result in the best all around product that plant facilities will permit, and can be justified from the standpoint of treatment cost. Since the author does not wish to infer that conclusions which he has reached are always entirely applicable to all plants treating similar waters, he will give rather detailed descriptions of the supplies and plant facilities covered by his experiences. On this basis the reader is invited to compare his experiences and observations with those of the writer.

The author's chief experience in treating medium soft water was that at Fort Smith, Arkansas, when Fort Smith was still using the Poteau River as a source of supply. During his experience with it, this supply frequently received backwater from the Arkansas River and at such times the water treated was actually a mixture of Poteau and Arkansas River water. In 1936 Fort Smith changed to a very soft mountain lake supply and the author was in charge of its treatment until late 1947, when he assumed charge of both water and sewage treatment at Austin, Texas. The Austin plant softens the relatively hard, lake fed, Colorado River water. In this article the author will give a rather complete description of Fort Smith's Poteau River supply and plant in order to give a clear picture of the type of water the consumers were accustomed to prior to changing to an extremely soft mountain lake water.

The Poteau River Supply

Fort Smith used the Poteau River for its source of supply from the late 1800's until early 1936. This river heads in Western Arkansas, meanders into Oklahoma, flows in a northerly direction through part of Eastern Oklahoma and then back into Arkansas at Fort Smith, where it joins the Arkansas River. The Poteau River Plant was located very near the Arkansas-Oklahoma boundary, the intake being located on the Oklahoma side of the river and in Oklahoma. The intake and plant were located approximately one mile above the mouth of the river and its confluence with the Arkansas River. The bottom or bed of the Poteau was essentially level for approximately ten miles upstream from the intake and for the mile downstream to the Arkansas River. During periods of low flow this part of the river was, therefore, similar to a long narrow lake, open at one end to the Poteau River and to the Arkansas River at the other end. This made conditions ideal for the Arkansas River to back into the Poteau at periods of low flow in the Poteau. At such times the plant, of course, treated varying mixtures of water from the two rivers.

Early settlers remember the Poteau River as a clear stream with abundant fish life. However, during the First World War and in the years immediately following, when the Western Arkansas and Eastern Oklahoma coal fields were worked extensively, the river is said to have received excessive quantities of acid mine water. We received some reports that there were periods during which the river water would be acid to methyl orange at the Fort Smith intake. However, since treatment plant records kept prior to 1925 were meager it is impossible to determine the quality of the water produced by the plant during this period.

From late 1927 until early 1936, the years when the author was in charge of operations at the Poteau River Plant, the river water was never acid to methyl orange. Very infrequently the alkalinity would drop below 10 ppm. but normally, with no Arkansas River backwater present, the alkalinity would vary from 10 ppm. to 40 ppm., depending on the season. The river received some acid mine water but this became neutralized before it reached the plant intake. It probably accounted for the fact that the water had a relatively high ratio of sulphate to bicarbonate hardness. The relatively low alkalinity and the high sulphate to bicarbonate hardness ratio in turn probably accounted

The Author

Having heard Mr. Ullrich speak on various occasions, the editors of *Water & Sewage Works* invited him to contribute a series of short articles reciting his experiences in water treatment.

The author received the Master of Science degree in Chemical Engineering from the University of Texas in 1925, having served as Instructor in Chemical Engineering thereafter. He accepted the position as Chem. Engr. in Charge of Water Treatment at Fort Smith, Ark. in 1927 where he had experience in treating two waters of diverse characteristics. He also served the city of Muskogee, Okla., and other smaller municipalities, as well as several industries, in an advisory and consulting capacity in connection with water treatment.

Since 1947 Mr. Ullrich has been Supt. of Water and Sewage Treatment at Austin, Texas, thus broadening his water treatment experience further. He is a past chairman of the Southwest Section of AWWA, and is a past chairman and Honorary Member of the Arkansas Water & Sewage Conference. In 1948 he was voted the Fuller Award by the Southwest Section of AWWA, and we feel that Mr. Ullrich is well equipped to contribute a helpful and interesting series of articles on his "Water Treating Experiences."

for the fact that the river water was never very clear, even during periods of low flow. Very infrequently the turbidity would drop below 25 ppm. and then it would be fine and colloidal in nature. During periods of high flow, turbidities ranging from 1,500 to 2,000 ppm. would be experienced. As the flow decreased the turbidity would also usually drop quite rapidly to 500 ppm. or less, but further decreases were usually slow. During high river stages the peak turbidities were avoided by taking water from the upper levels. The intake tower was equipped with three intake valves located at varying elevations, which made a certain degree of selection possible. The muddy nature of the river no doubt discouraged the growth of algae, which made the water relatively free from tastes and odors.

In general the characteristics of the raw Poteau River water, as shown by the author's 1935 records, were as follows:

	Low	High	Medium
Alkalinity	10.0 ppm.	40.0 ppm.	20.0 ppm.
Total hardness	60.0 "	140.0 "	85.0 "
Sulphate hardness	50.0 "	100.0 "	65.0 "
Chloride	4.5 "	11.0 "	6.0 "
Turbidity	25.0 "	2,000.0 "	150.0 "

An analysis made by the U. S. Geological Survey on treated Poteau River water when the supply was at its best is given below. The sample for this analysis was collected on November 12, 1931.

Silica (SiO_2)	6.2	ppm.
Iron (Fe)	.01	"
Calcium (Ca)	21.0	"
Magnesium (Mg)	3.6	"
Sodium (Na)	5.7	"
Potassium (K)	2.6	"
Carbonate (CO_3)	0.0	"
Bicarbonate (HCO_3)	40.0	"
Sulphate (SO_4)	39.0	"
Chloride (Cl)	6.8	"
Nitrate (NO_3)	.94	"
Total dissolved solids	109.0	"

While the treated Poteau River water was not always as good in quality as when the above analysis was made, it was normally superior to most waters. The fault in the supply was not the quality of the Poteau River water but the poor quality of the Arkansas River backwaters which were obtained at frequent intervals and at times for long durations. The Arkansas River water, especially at low river stages, carries high chloride (salt) and high hardness concentrations. In addition to a saline taste caused by the high salt content the water may also carry a very objectionable woody taste. Many of the river's tributaries are subject to flash floods and the Arkansas, therefore, frequently carries high turbidities even at relatively low stages. Since the river is generally accepted as being unsuitable for use as a source of water supply, most cities along its course have until now been permitted to discharge their sewage into it without benefit of prior treatment.

Since the bottoms or beds of the Arkansas and Poteau River were essentially at the same elevation at the mouth of the Poteau (and, as previously mentioned, ten or eleven miles upstream from the water plant) very small rises on the Arkansas could and would back into the Poteau when the latter was at low stage. At one time a six-inch rise on the Arkansas caused Arkansas River backwater to reach the Poteau River Plant. At another time, during a severe drought on the Poteau, Arkansas River water flowed into the Poteau to the plant intake although no rise was reported on the Arkansas. These low stage backwaters gave the author his first experience in the stratification of waters. The Arkansas water, being high in salt content and sometimes exceedingly turbid, had a higher specific gravity than the Poteau water. Being heavier it would actually flow up-stream along the bottom of the Poteau, while the lighter Poteau water would flow out on top. Unfortunately during low river stages the treatment plant was forced to take water from the bottom intake valve because the second or middle valve would be exposed. It was, therefore, necessary to pump and treat the high salt content water during most of the backwater periods. During one backwater period when the plant was treating water which had a chloride content of between 1,100 and 1,200 ppm., and a turbidity in excess of 15,000 ppm., we could not see the turbid water from a row boat because a layer of lower turbidity Poteau water was on top. The turbid water could, however, be brought to the surface by vigorous churning with an oar.

As will be noted later, the filtration plant did not have a mixing chamber or flocculator for slow mixing so that after a very short quick mix, the treated water flowed directly to the settling basins. Therefore, during normal operation and with the settling basin full of treated Poteau water, if high salt content and high turbidity water was suddenly received and treated this would settle straight to the bottom of the basin. Then, instead of displacing the water in the basin from the inlet end, it would displace it from the bottom until all the lighter water was pushed out onto the filters. This caused us severe headaches on several occasions because the operator thought he was treating the water properly until suddenly he found that the entire basin was full of turbid and improperly treated water.

The characteristics of the Arkansas River backwater as received at the plant varied, of course, with the Arkansas River itself and with the extent of its admixture with Poteau River water. Chloride concentrations in excess of 10 ppm. were taken as evidence of the presence of backwater. The author's records show that the chloride content was in excess of 10 ppm. during 165 days in 1932, 163 days in 1933, 181 days in 1934 and 104 days in 1935. As previously noted, the Arkansas River water also carried higher alkalinity, hardness and turbidity concentrations than did the Poteau River water. The following table gives the approximate high values for these items for the Poteau water and for the backwater as received at the intake.

	Poteau River Water	Arkansas River Backwater
Alkalinity	40.0 ppm.	110.0 ppm.
Hardness	140.0 "	250.0 "
Chloride	10.0 "	1,200.0 "
Turbidity	2,000.0 "	15,000.0 "

Treatment Plant Facilities

The intake tower, as previously noted, had three intake valves located at varying elevations. This made it possible to take the less turbid water from the top of the river during high river stages.

The pump room had duplicate 8.0 mgd. low lift (river) pumps and duplicate 8.0 mgd. high lift pumps. Both low and high lift pumps were steam turbine driven centrifugal units with speed variations possible so that their efficiency changed but little between 6.0 mgd. to 8.0 mgd. pumping rates. However, below 6.0 mgd. their efficiency dropped quite rapidly. Since one low and one high lift pump always operated together it was necessary to operate the entire plant at a 6.0 to 8.0 mgd. rate when the plant was in operation. There was nothing very unusual about the pumping plant except that the pump capacities were so much greater than the daily water usage, which, from 1932 through 1935, was never greater than 3.0 to 3.5 mgd. and averaged approximately 2.25 mgd. The over design of the pumps was explained by the fact that prior to 1927 Fort Smith was far from com-

pletely metered and when the pumps were installed the water usage often exceeded 4.5 mgd. More complete metering plus the depression probably caused the reduction in water usage. In 1934 we considered installing a smaller pumping unit in the event plans for a new source of supply were not approved.

From the low lift pumps the water passed directly to the head house where alum and lime were added to it in a very small baffled quick mix chamber. From there the mixed water flowed directly to the settling basin. There was no flocculator or other type mixing chamber for slow mixing.

The settling basin was a large affair with a five mil. gal. capacity. The bottom sloped from the middle and from the sides to two drain valves. From the sloping bottom, the sides and ends sloped up at a 45° angle to within five feet of the top. Only the top five feet of the sides and ends were vertical. The basin had a depth of thirty feet in the middle. When originally built, the basin had a brick cross-baffle at the half-way point. This baffle, or wall, had a row of ports some six feet from the bottom. These were equipped with flap valves so in case of draining the inlet end, the water in the outlet end could not flow back. At one time the inlet end of the basin was drained for cleaning without draining the outlet end. The brick baffle-wall collapsed, killing a workman. While this happened before the author became associated with the plant he has always remembered it as a warning not to build a dividing wall, a baffle which will not automatically equalize the water pressure on both sides, or even a flume which will not withstand the full hydrostatic pressure which may be placed against it.

When the author became associated with the plant the original brick baffle had been removed and there was no baffle in the basin. Short circuiting was very bad; the mixed water was introduced near the top of the inlet end and from there it would flow down both sides leaving a large oval-shaped body of clear water in the center of the basin. While the basin had a theoretical detention time of from 18 to 21 hours, excessive amounts of floc would reach the filters in less than one hour after the plant was started. This condition was greatly improved by installing a wooden stilling and distributing baffle some twelve feet from the inlet end of the basin. Since the plant had no flocculator or slow-mix mixing chamber the body of water behind the baffle seemed to improve floc formation as well as still the water and distribute its flow more evenly. At any rate the baffle not only improved the settling characteristic of the basin but it also made possible a substantial reduction in coagulant dosage.

The filter plant had eight filters, rated at 1.0 mgd. each. These had manually operated valves and no rate of flow controllers, loss of head or rate of flow gauges. The underdrain system consisted of perforated brass plates grouted in place between concrete "ridges"—the space beneath the brass plates and between the concrete "ridges" serving as laterals. The filtering media consisted of conventional filter sand supported by layers of graded gravel. From the filters the water flowed to an open clear well, from which it was pumped into the distribution system and into open high elevation storage.

The plant laboratory was equipped for complete bacteriological testing and for such routine chemical tests as hardness, alkalinity, chloride and turbidity. The pH test for routine control was added later.

Intake Tower, Old Poteau River Filtration Plant, Fort Smith, Ark.

CHLORINE DIOXIDE TREATMENT AT VALPARAISO, IND.

by

RICHARD COOTE
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THE Valparaiso water supply is taken from a small inland lake located three miles north of the city. This lake is fed by a series of other lakes and normal runoff from the drainage area. The intake is located 375 ft. from shore in about 13 ft. of water and five feet of muck. With the intake in shallow water and numerous weeds in the area, the raw water at seasonal periods has a very offensive taste and odor.

The Author

Two Odor Periods

These periods are divided into two principal periods: the algae periods, and the lake turnover periods. The algae periods are usually in June and July and at this time very high algae and protozoa counts are recorded. The taste and odors during these periods are those descriptive of Anabaena, Asterionella, Synura, Vorticella, Melosira, Ceratium, Cyclops, etc. These tastes and odors have caused a good deal of trouble in the past and had been a constant source of complaint each year during these months.

The turnover periods have caused even more trouble, for the taste and odors are much more offensive, and it seems much harder to reduce the threshold to the palatable level. These periods are during the cold water temperature periods, but the plant tap still has very bad taste and odors in these cold temperatures.

Our water plant, like many others, has been greatly overloaded the past few years, and for this reason treatment has had to be in accordance with the shorter time periods. By the overloading of the plant as a whole and the increased filtering rate our filters were passing higher turbidities than they should, and for this reason carbon had to be used very sparingly. For this reason, too, during high threshold odors of the raw water, we obtained very little reduction in taste and odors. We received some help on some types of tastes by the use of free residual chlorination (break-point process) but this was not a cure-all and did not help at all times. We did a great deal of work on break-point and proved that it did not increase the taste and odors in any way. This was easily confirmed by going off break-point and using combined residual chlorine treatment. The taste and odors always increased during these periods.

Chlorine Dioxide Treatment

In June, 1948, during a very severe algae period we decided to try chlorine dioxide treatment in an effort to turn out a palatable water. At the time we started treatment the following thresholds and chemical dosages were being recorded:

Tap Cold	Raw, T.O. (Hot, dechlorinated)	Tap T.O.	Carbon Dosage
Very musty odor Very bitter taste	40	12	5.0 ppm.

The above was recorded at 10:00 A.M. on June 16, 1948.

The chlorine dioxide treatment was started at 3:00 P.M., June 16, 1948, by John Matarese, Mathieson Alkali Co. and the following were recorded at 8:00 P.M., June 16, 1948:

Tap Cold Taste and Odor	Raw water	Tap T.O.	Chlorine Res.	Chlorine Dioxide Dosage
No taste, slight cl. odor	40	5	1.5	8.0 lb. per mil. gal.

As can be seen the quality of the water was greatly improved. We were greatly pleased with the results and finding the next day that the water leaving the plant was still very good we decided to sample the distribution system. Realizing that the treatment had not been in operation too long, we were not too optimistic as to the results we would find.

We still have 8 or 9 miles of wooden main remaining in our system of 29 miles so we checked the cast iron areas first. We checked hospitals, restaurants and private homes, and the water at these places was very good. After finding these results good, we decided to check the wooden main and dead end areas where complaints had been common. It was immediately noted that in the wooden pipe areas the normal wood taste was either eliminated or greatly improved. The dead ends were still bad, but this was to be expected.

The same areas were checked a week later and found to be generally very good. One thing noted at this time, which had been noted in our use of chlorine dioxide, was that at times during the treatment the water at the pumping station would have a more definite taste than at a point a mile or two away. We have had very little trouble with an odor increasing after the water left the plant. If there is any taste or odor it is usually from some other cause.

We continued treatment with decreasing doses of chlorite, depending on the type and severity of the odor, until late August. At that time the raw water was sufficiently good so that no treatment of any kind was necessary.

Tastes But No Odor

We used chlorine dioxide treatment in September for part of the time when the water had a slight taste but did not have any severe taste and odor periods until October. One thing has been noted at Valparaiso. We often have short but severe attacks of Synura in the late fall causing a very bitter taste. The threshold odor is usually low but the taste test is high. In the latter part of September, 1948, we had one of these short taste periods, lasting about a week.

We ran diluted taste tests and found the taste test to be a dilution of 20-1. We started the chlorine dioxide and within a few hours had reduced the dilution to 2 to 1 before the taste could be detected; by the next morning the bitter taste could not be detected on the plant tap water at all. At this time both the raw and tap thresholds were low, giving no indication of an unpalatable water.

Since that time if at any time a bitter taste develops we immediately use chlorine dioxide (3 to 8 lb. per mil. gal.) to relieve this taste condition. These taste periods happen very often during the winter months and this has been of great help in keeping complaints at a minimum. It has also been noted in the last year that many points on the distribution system, dead ends and wooden main area, where taste complaints were frequent have either cleared up completely or greatly improved. One dead end area in particular was checked about a month after starting treatment and there has not been one complaint from this area since that time, which is over a year. It is periodically checked and unless the water is bad at the plant there is no trouble in this area.

October Tastes and Odors

The next bad period of taste and odor developed in the middle of October. We have two wooden intakes supplying the plant from the lake and during a very high wind storm a leak developed in this intake causing very high turbidity and high raw threshold odors. Table I shows the laboratory findings of that day showing the rapid change in the raw water.

(We have just completed 378 ft. of new intake with a 6 ft. riser which should greatly help this condition.)

We had been very anxious to see how chlorine dioxide would act under this condition and were pleased with the results. If we can reduce the threshold on the plant tap to a T.O. of 5, we do not have any trouble with complaints on taste and odor. The odor at this T.O. is very slight and not too offensive, even on a hot water sample. Table I data show that before many hours the Tap T.O. was dropped from T.O. of 14 to a T.O. of 4, which is very good.

This taste and odor period was not too long in duration but we had several after this or until the lake froze over. High winds were a contributing factor.

Spring Turnover

In 1949 we had our spring turnover period in March. It was the worst period in two years. I am sure that the condition of the intake was a direct cause of the severity of the period.

We were able to keep the tap T.O. between 5 and 7 but at the higher figure there was a slightly bitter taste. It was during this period that we considered post treatment of chlorine dioxide on the discharge of the high lift pumps. The tap T.O.

Table I

Time	Sample	Turbidity	Alk.	Chlorine Res.	Thresh. Odor	Alum. Dose	Chlorine lbs. mil. gal.
10:00 A.M.	Raw	3.0	76		10	1.2	52.0
10:00 A.M.	Tap	0.5	63	1.5	4		
3:00 P.M.	Raw	550.0	134		60	2.0	60.0
4:45 P.M.	Tap	6.0	129	0.35	14		
6:00 P.M.	Tap	1.5	89	1.0	5		
9:00 P.M.	Raw	700.0	133		70	2.0	64.0
9:00 P.M.	Tap	1.0	89	1.4	4		

It is apparent from Table I that the raw water changed very rapidly in a matter of a few hours. The odor of both the raw water and tap water was a very sour weedy odor. It was a sickening odor and quite strong in the cold water at a temperature of 52° F. Within an hour after chlorine dioxide treatment was started at 10.0 lb. per mil. gal., the odor was very slight in the hot water and no odor was in the cold. It was three hours before the water coming out of the clear well had a palatable odor. This is equivalent to the detention time in the plant.

This type of odor is common during the turnover periods and at times when the lake becomes very rough. It is due to the churning of the muck bottom of the lake. The intake has no riser and has about 3 feet of muck in that area, and any time that the lake bottom is disturbed we get this very bad sour weedy odor.

was 7; no odor cold but a strong musty odor hot. In the laboratory we set up samples of different doses of chlorite and some with post treatment. The post treatment results dropped the T.O. to 3 with a medicated odor. We then tasted the samples and the sample with a T.O. of 7 had a slight bitter taste, while the T.O. 3 sample had a strong oily taste. This latter was very sickening and definitely ruled out post treatment. Apparently we could use pre- and post-treatment but not post treatment alone. We, therefore, continued pre-treatment dosage and have found that we get satisfactory results by this method of feeding. I believe that there is an advantage to pre-treatment because the operator has ample time to check thresholds and taste tests as the water comes through the plant. I know many times we have been able to check the water on the filters and if the chlorite feed was too light to increase the feed and therefore save time in correcting an underdosed water. If this had happened on post-feed, it might not have been detected as quickly, for after the water leaves the high lift pumps we could not know if it was lack of detention time or underdosing.

During the latter part of the spring turnover period the raw water had a very fishy odor. We made an algae count and found many Mallomonas. This was unusual in that during the turnover periods very few algae are present, and it has always been a weed condition. Chlorine Dioxide handled the condition very easily, however. The raw T.O. at this time was 30 (very fishy) but was easily reduced to a Tap T.O. of 4 with a small dose of chlorite (3 to 4 lb. per mil. gal.).

We had periodic periods of taste and odor and used chlorine dioxide in small doses almost continually from the first of the year until the beginning of May. The first half of May the water was so good that no treatment of any kind was needed. By the 20th of May, however, algae counts were increasing and by the first of June, 1949, we were back on small feeds of chlorite. Results obtained between June 12th and 18th are shown in Table II.

More Troubles

From the results in Table II it is obvious that the raw water was rapidly getting extremely bad, and, to make this condition even worse, the construction of the new intake was started. This construction required some dredging near the present intake. The dredging naturally stirred up the bottom, causing a water of high turbidity and foul odor to be drawn into the plant starting on the 17th. On the 19th we saw where the condition could not be handled with chlorine dioxide alone, so we decided to try a small amount of car-

Table II

Date	Raw water T.O.	Tap T.O.	Algae count	Chlorine demand Break-Point ppm.	S-d. Chlorite lb./mil. gal.
6/12	14	4	250	7.5	4
6/13	22	5	780	8.0	6
6/14	30	5	1100	8.0	10
6/15	46	10		9.0	16
6/16	40	4	2950	9.0	20
6/17	60	12	5000	10.0	32
6/18	70	7	7800	11.0	32

bon with chlorine dioxide. The maximum feed of carbon that the plant will handle without passing the filters is 5.0 ppm. This is due to very short settling time (1 hr.) and poor sedimentation. (This condition will be relieved with a 360,000 gal. clarifier now in construction.)

Carbon dosage was started at 10:00 A.M. at 5.0 ppm. and the results shown in Table III were recorded.

Table III

Time	Raw T.O.	Tap T.O.	Cl_2 Res. ppm.	Cl_2 Feed ppm.	Carbon Feed ppm.	Chlorite lb./mil. gal.
8:30 A.M.	60	7	2.0	11.0	0	20
12:30 A.M.	60	5	1.3	11.0	5	16
3:30 P.M.	60	4	1.3	11.0	5	16
7:00 P.M.	60	5	1.2	11.0	5	16

By 3:00 P.M. the water had a very slight musty odor hot, but no taste or odor cold. We kept this method of feed for about a week and by that time the raw water threshold odor was down to T.O. 40 and the dredging was complete. At that time we were able to turn out a tap T.O. of 4 with 6.0 lb. per mil. gal. of chlorite. Because this condition was very unusual I refer to it to show that, if necessary, carbon and chlorine dioxide can be used together with good results. Since that date we have been able to handle the normal seasonal odors with small doses of chlorine dioxide alone (3 to 8.0 lb. per mil. gal.).

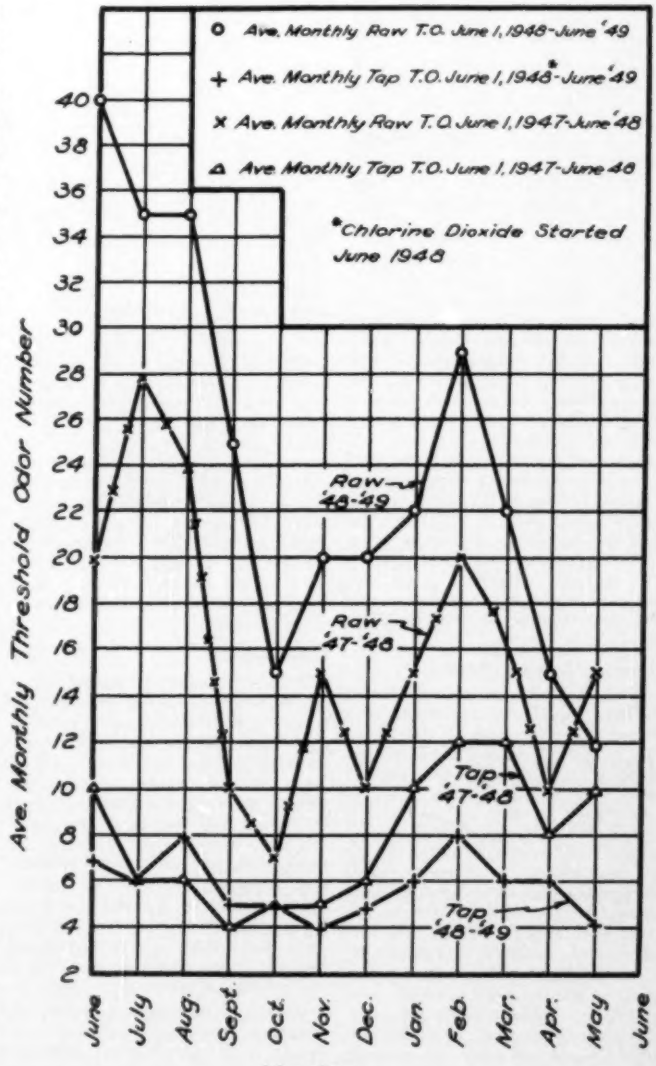
Through our experience with chlorine dioxide treatment we have found the cost is not in excess of other treatment. At times it may take large doses (10-32 lb.) to reduce a very bad odor but the average dose at Valparaiso for any taste and odor period has not been too high. In the past year we have been able to handle a very bad taste and odor condition in such a manner that complaints have been held to a minimum. A palatable water has been served the consumer most of the time under very poor plant conditions. When the new plant construction is complete and proper plant conditions are available, it will be possible to do even a better job with chlorine dioxide.

Close Control Helps

I might point out at this time that close laboratory control using the threshold odor method has given us some valuable data with which to work; and when these periods occur using information which we have available has been a very great help in taste and odor control. We use stoppered flasks and find that this method is much superior to the old method of watch glasses. Stoppered flasks do not allow the odor to escape and for this reason odors are much more easily detected and identified.

By taking raw water samples and treating with aliquot portions of chlorine dioxide in the laboratory, one can easily determine the dose which will produce the water with the lowest threshold and in this way often save valuable time in determining the correct dose for a particular taste or odor.

On tastes we dilute the water to be tested and allow as many persons as are present to taste the different dilutions. By averaging the several observers' results and setting a chlorine dioxide dose to produce a water of this standard, it is usually possible to produce a water with a taste which is acceptable to everyone. These taste reactions are made blind



Average Monthly Threshold Odor Numbers at Valparaiso, June, 1947—June, 1949

so that the person tasting the water does not know the dilutions he is tasting and therefore his reaction is a true reaction. These methods of control are simple and give valuable records for future use. We have used these in all bad taste and odor periods and find the work worth great value.

Reduce Chlorine Odors

The use of chlorine dioxide has proven very beneficial in control of any chlorine odor. It has been found that when using chlorine dioxide much higher free chlorine residuals can be used without the chlorinous odor. Some types of taste during the former turnover periods have been handled with high chlorine residuals, but during these periods there were always some chlorine odor complaints in areas where residuals were as high as 1.2 ppm. Excess chlorine treatment did, however, eliminate the muck taste and for this reason (before the use of chlorine dioxide) we did employ high free chlorine residuals.

When using chlorine dioxide, we found that higher chlorine residuals could be used with no severe chlorine odor. During one period of this type we carried a plant tap residual of 3.5 ppm. and system residuals of from 1.5 to 2.0 ppm. with no complaints. At that time small doses of chlorine dioxide (2 to 3 lbs. per mil. gal.) were used with very good effect.

Tastes generally are bitter and noticeable and odors vary in character depending on the cause, but the worst type of odor is that when the lake bottom is disturbed in any way. This decayed vegetation odor is very offensive and with the highest T.O. has been by far the hardest to control, but chlorine dioxide has been an effective control.

Handling Sodium Chlorite

There has been some discussion on the handling of sodium chlorite as to safety. We have had no trouble in this respect. We are careful in handling sodium chlorite and do not store it in a place where there is any chance of fire; if any of the material is spilled on the floor it is immediately swept up and disposed of. No smoking is allowed around the feeding equipment but other than these measures no further precautions are taken; we feel safe and have had no reason to feel otherwise.

Our feeding equipment and generation is simple and foolproof. Our generator is connected to the discharge hose of our pre-chlorinator and we use chlorine to generate chlorine dioxide. This does not in anyway affect our break point treatment and is simple and saves the additional chlorinator. We have two 16 gal. crocks in which the chlorite is made. This leaves one in reserve at all times, so all the operator has to do is change his pump suction from one crock to another. As soon as the crock is empty the operator immediately weighs in a new amount of chlorite as prescribed by the desired dosage, fills the crock with water and it is ready for use. Any good proportional pump is all that is needed for feeding of the chlorite. They are not too expensive and are easy to operate. The feed is accurate and therefore over- or under-dosing is no problem.

We had both the pump and generator on a trial basis for almost a year before we purchased the equipment. The manufacturer felt that we should have ample time to try the treatment out under all conditions possible so we would be sure that the treatment satisfied our conditions. We carried out many experiments under different conditions in the months we had the equipment, came to the conclusion that it was doing a good job and then purchased the equipment.

Other Benefits

There is another reason why chlorine dioxide treatment is advantageous. It is a stronger oxidizing agent than chlorine and has a strong sterilizing effect. We have not had time to carry out any work along this line but we hope to have time to do work on this at a later date. We have noticed that when we are using chlorine dioxide our prechlorine dosages can be lowered and the residuals can be lowered due to a lower demand when using chlorite. Also the system residuals seem to hold up much better in the higher water temperatures.

We are now completing new construction which will help us very greatly with all types of taste and odors, and we know that with longer periods of time in the plant, better clarification and settling, and the use of chlorine dioxide will help to remove some of the odors and that even better results will be shown than heretofore. During some laboratory work we have used the coagulation and plant time which will be used in the new plant improvements, and during the experiments very good results were recorded with lower doses of sodium chlorite.

In Table IV are some cost comparisons from previous periods of taste and odor; and the cost of chlorine dioxide treatment has not been any more than any other treatment over the same period.

It will be noted from Table IV that while the chlorite cost averaged $0.86 more per mil. gal. than the cost of carbon, the amount of chlorine used with chlorite was less in the amount of $1.17 per mil. gal. than with carbon. Thus the actual cost of treatment with chlorine and chlorite was $0.31 less than treatment with chlorine and carbon.

Table IV

Chemical Treatment Dosage

Period	Sodium chlorite—lb. per mil. gal. Avg. high Month	Avg. Low Month	Avg. Dose	chlorine—lb. per mil. gal. Avg. high Month	Avg. Low Month	Avg. Dose
6-1-48 to 6-1-49	10.8	2.9	6.6	74.0	46.0	60.8
	Carbon—lb. per mil. gal.			Chlorine—lb. per mil. gal.		
6-1-47 to 6-1-48	43.0	18.7	4.0	89.0	75.5	55.0

Cost of Chemical Treatment Per Mil. Gal.

6-1-47 to 6-1-48	Carbon $1.31	Chlorine $7.55	Carbon plus Chlorine $8.86
6-1-48 to 6-1-49	Chlorite $2.17	Chlorine $6.38	Chlorine plus Chlorite $8.55

Whenever high doses of carbon are used it takes much more chlorine, and for this reason this must be considered. Also our storage space is very small and we can only at the present time handle small shipments of carbon; this therefore affects the price per lb. Chlorine dioxide has helped through its high oxidizing power to lower the chlorine demand to a small degree and therefore saves on chlorine. Also sodium chlorite doses are small and storage is no problem.

All these factors have to be taken into consideration and we here at Valparaiso do not feel that the cost of chlorine dioxide treatment is any more than any other treatment. Also we appreciate greatly the fact that we are now able in part to control a very bad condition which before this treatment we could not control.

In conclusion we feel that the introduction of chlorine dioxide treatment into the water works field will be an additional factor in the production of a pure and palatable water.

CHESAPEAKE SECTION A.W.W.A. FIRST MEETING

Washington, D. C. Conference Really 33rd for the Group

MEETING in Washington, D.C., on Nov. 2-4, 1949, the new Chesapeake Section of A.W.W.A. held its first annual convention. Actually, as pointed out at the business

Chairmen

Incoming
Clark Gardner
Supt. & City Engr.
Water Dept.
Salisbury, Md.

Outgoing
E. A. Schmitt
Head Engr.
Wash. Aqueduct
Washington, D.C.

session, it was the 33rd meeting of the group, inasmuch as this section is the only remaining part of the original Four-States Section. First part of the original section to be swept off was Southern Jersey which joined the New Jersey Sect; then last year the eastern half of Pennsylvania was removed to join western Pennsylvania and form the Penna. Section. Thus the only remaining area consists of the states of Maryland and Delaware and the District of Columbia. The interest of some of the former members was evidenced in their attendance.

With a membership of 209, a gain of 32 since last May, the registration was 196, including 67 manufacturers, and excluding more than 20 ladies.

New Officers

The following officers were elected for the ensuing year:

Chairman
Clarke Gardner, Supt.
Water Dept.
Salisbury, Md.

Vice Chairman
David Auld, Supt. & Chief Engr.
Water Dept.
Washington, D. C.

Secy.-Treas.
Carl J. Lauter, Sr. Chem. Engr.
Purif. & Oper. Div.
U.S. Corps. of Engrs.
Washington, D.C.

A.W.W.A. Director
Carl Hechmer, Dept. Engr.*
Washington Suburb. San. Dist.
Hyattsville, Md.

Trustees
R. C. Willson, Supt.
Water Dept.
Hagerstown, Md.

W. Compton Mills, Mgr. & Ch. Engr.
Water Dept.
Wilmington, Md.

E. A. Schmitt, Ch. Engr.
Washington Aqueduct
Washington, D.C.

E. S. Hopkins and J. H. Strohmeyer of Baltimore continue as trustees.

Fuller Award
Edw. S. Hopkins
Assoc. Engr.
Bur. Water Sup.
Baltimore, Md.

Fuller Award

The Fuller Award Committee selected to receive the 1949 Fuller Award for the Chesapeake Section, Edw. S. Hopkins, with the following citation: For his outstanding work in the field of Sanitary Chemistry, especially in coagulation problems related to water purification.

Opening Session

With E. A. Schmitt, Chairman, presiding, the address of welcome was given by **Lt. Col. C. H. Whitesell,** Asst. Engr., Engineering Commission, Washington, D.C. Col. Whitesell explained some of the difficulties that had beset a growing Washington when it came to supplying an ever-increasing demand for water.

*Elsewhere in this issue is an account of the sudden passing of Mr. Hechmer.

Middle Atlantic States Water Supply

"QUALITY CHARACTERISTICS OF WATER SUPPLIES IN THE MIDDLE ATLANTIC STATES" by S. K. Love,

Vice Chairman
D. V. Auld
Supt. & Ch. Engr.
Water Dept.
Washington, D.C.

Secy.-Treas.
C. J. Lauter
Sr. Chem. Engr.
Purif. & Oper.
Washington, D.C.

Chief, Quality of Water Board, U.S. Geological Survey.

Generally throughout N.J., Del., Md., the D.C., and Va. the water is good and soft. The largest cities obtain water from surface supplies, but there are more ground water supplies than surface supplies in the area. Mr. Love showed slides of characteristics of surface waters, pointed out how and why they vary, and by means of colored cards showed the composition of waters at various localities.

Safety

"PRACTICAL SAFETY IN WATER WORKS" by R. L. Jenkins, Chief, Safety Div. Office, Chief of Engineers, Washington, D.C.

Mr. Jenkins complimented the water works industry on its safety record but pointed out that it still should improve itself. In modern society we depend on safety measures for survival, and that includes safe water.

Although there has been a good job done in safety in industry, last year there were 98,000 killed and 10 million injured. Accidents cost $7.5 billion a year. There are an "awful" lot of little accidents.

Everyone must wake up to the importance of his own part. While water works men do not tolerate gambling on the safety of water they do gamble on unsafe practices in water plants.

Safety is not a commodity one can buy either through insurance or a safety engineer. To control accidents, it is necessary to start with management and work down through every level of supervision.

Mr. Jenkins explained how safety could be accomplished and gave the most important categories into which accidents may be grouped, such as falls, mechanical failure, exposure to risk, and acts of God. Most accidents involve two or more of these categories. In closing Mr. Jenkins pleaded for the creation of a safe environment and the inducement of all concerned to respect it.

S. C. Blackburn
Prin. Asso. Engr.
Bur. Water Sup.
Baltimore, Md.

C. A. Hechmer
Dept. Engr.
Wash. Sub. San. Dist.
Hyattsville, Md.

Presiders, Panel Moderators, Programmers

H. R. Hall
Ch. Engr.
Wash. Sub. San. Dist.
Hyattsville, Md.

J. C. Geyer
Prof. San. Engr.
Johns Hopkins
Baltimore, Md.

W. H. Cary
Director
Bur. Pub. Hlth.
Washington, D.C.

J. M. Jester
Div. Engr.
Wash. Sub. San. Dist.
Hyattsville, Md.

OPERATING ASPECTS

Under the direction of **Harry R. Hall,** Ch. Engr., Washington Suburban San. Dist., Hyattsville, Md., as Moderator, a Panel Discussion was held on Operating Aspects.

Plant Shutdowns

"PLANT SHUTDOWNS FOR REPAIRS AND IMPROVEMENTS," by D. M. Watt, Const. Engr., Washington Aqueduct, Corp of Engineers, Washington, D.C.

Mr. Watt called attention to the need for thorough planning for shutdowns, and described four occasions when the Dalecarlia plant had to be shut down. One of these shutdowns was for the purpose of cleaning a large conduit. Pictures were shown of the machine constructed for the cleaning job.

Small Plant Experiences

"EXPERIENCES AT A SMALL PLANT" by Francis Gosnell, Operating Manager, Laurel, Md.

This was a story to warm the hearts of everyone who had ever operated an old time water plant and kept it going with a few bolts, some baling wire, and a prayer. The Laurel plant has been operating since World War I with practically no capital improvement. Originally designed for a capacity of 200,000 gpd., it is now producing 500,000 gpd. with maximum rates of 800,000 gpd.

With a small reservoir, algae troubles, only 50 minutes' detention in the sedimentation basin, and such problems as snakes in the suction of the low lift pumps, this plant has continued to turn out an acceptable product. Credit for this feat goes not only to Mr. Gosnell but to his father, who at 81 still operates for two hours each day. The elder Gosnell had run the plant for more than a quarter century.

With 89 customers, the income is $24,000 annually, half of which goes to the city general fund pool, instead of to the purchase of new equipment for the improvement of operation.

Summer Problems

"SUMMER PROBLEMS" by J. M. Jester, Div. Engr., Washington Suburban Sanitary Dist., Hyattsville, Md.

Mr. Jester reviewed the problems of the District, its 198 square miles of area and its 808 miles of mains which demand 20 to 27 mgd. of water daily even under the restrictions of dry weather rules. Last summer the Sanitary District had to borrow water from Washington, D.C. Cutting in a main to obtain the extra water presented a problem not only in main tapping, but also in coordinating several agencies involved.

New Look Outlook

At the opening of the second session the motion picture "LIFE STREAM" was shown. This was the picture of the operation of the Kansas City, Mo., water works.

"NEW LOOK KEYNOTE," by Dr. A. P. Black, Head, Chemistry Dept., University of Florida, and President of the A.W.W.A.

Dr. Black said that among the important features of the "New Look in Water Works" is the ability to differentiate between the two forms of residual chlorine. Even as we have come to recognize this importance, it has been found that the tool for making the differentiation has its weaknesses; the O.T.A. test needs refinement.

Another important aspect of chlorination is the discovery that the germicidal agent is HOCl and that the mechanism of bacterial kill is through the effect of HOCl on the enzyme oxidase.

Still another important factor in modern taste and odor control is the use of chlorine dioxide which is undergoing intensive application tests.

Probably the latest information available on the subject of corrosion was that presented by Dr. Black on the role of hydrogen peroxide in corrosion of iron in water. Through hydrogen peroxide, percarbonic acid is formed, and this percarbonic acid has a much higher dissociation constant (ten times) than does carbonic acid and therefore is ten times as corrosive.

According to Dr. Black, properly designed, properly engineered, and properly operated cathodic protection will prevent corrosion.

Biological Problems of Reservoirs

"BIOLOGICAL PROBLEMS OF MIDDLE AND OLD AGE RESERVOIRS" by Charles Renn, Assoc. Prof., Johns Hopkins University, Baltimore, Md.

Prof. Renn said that impoundments age and tend to become swamps. This is known as "Eutrophication" and is due to the pollution enrichment of the lakes whereby algae, diatoms, and other organic forms grow profusely in the "fertilized" waters. At least forty lakes have deteriorated in our lifetime. Even Lake Geneva in Switzerland has deteriorated.

Loss of clarity of these lakes is not due to filth added to the lake but to the change in fertility and growth of these aquatic organisms. There is an increase in mud content, weeds, and temperature and a decrease in game fish. Eventually a swamp results.

Prof. Renn showed slides of actual organisms collected from some of these eutrophic lakes. By means of unique projection equipment, Prof. Renn was able to throw on the screen enlargements of the living organisms

in their native colors. According to Prof. Renn, it is possible to read the age of a reservoir from the type and number of organisms present.

Elkton, Md. Water Supply

"EXPANSION OF ELKTON, MD. WATER SUPPLY SYSTEM" by Robert T. Regester, Cons. Engr., Baltimore.

Behind the Scenes

J. C. Smith
Corp. Engrs.
Washington
D.C.

Geo. Harrington
Corp. Engrs.
Washington
D.C.

Programmers

Chas. Renn
Assoc. Prof.
Johns Hopkins
Baltimore, Md.

R. T. Regester
Cons. Engr.
Baltimore
Md.

J. H. Strohmeyer
Dep. Water Engr.
Bur. Wat. Sup.
Baltimore, Md.

G. M. Hitchcock
Supt.
Evitts Cr. Water Co.
Cumberland, Md.

Mr. Regester described the water supply situation in Elkton and the existing water supply facilities and distribution system; also the enlargement of the filtration plant to provide an additional 300,000 gpd. capacity to meet rapidly increasing demands.

Sub-Aqueous Water Main

"LAZARETTA-FT. MCHENRY-FAIRFIELD SUB-AQUEOUS WATER MAIN," by J. S. Strohmeyer, Deputy Water Engr., Baltimore, Md.

(Our reporter was unable to cover this paper and regrets that no abstract can be given of it.)

Anthrafilt

Before the first paper at the third session, a motion picture was shown. This picture titled "Not a Drop of Water" comes from England and shows the water system of the City of London.

"ANTHRAFILT THROUGH TWO DECADES" by G. M. Hitchcock, Supt. Evitts Creek Water Co., Cumberland, Md.

Cumberland has much of the original coal dredged from the river in its filter plant. Some nine inches of Anthrafilt were added in 1938, and surface wash has been added, but the installation remains as the oldest anthracite coal filter in the country with more than three decades of service.

Mr. Hitchcock devoted most of his paper to a very interesting history and appraisal of James H. Fuertes of Cornell University, the man who first proposed the use of anthracite for water filters, because of its characteristics of more angular surfaces, lighter density, and inert chemical characteristics.

Technical Services

"OBTAINING TECHNICAL SERVICES FOR SMALL COMMUNITIES" by T. M. Niles, Partner, Greeley and Hansen, Engrs. Chicago, Ill.

Mr. Niles pointed out that small structures cost more per unit capacity than do large ones, and, therefore, small communities need good engineers to keep costs at a minimum. Mr. Niles' paper was devoted to what could be expected from technical services and how to find these services.

Health Hazards

"OCCUPATIONAL HEALTH HAZARDS IN WATER WORKS SYSTEMS" by W. H. Cary, Jr., Dir. and P. J. Valaer, Ind. Hygienists, Bur. Pub. Health Engr., Washington, D. C.

Good health is a positive condition, not just the absence of infection or injury, according to Mr. Cary, who presented the paper. The purpose of the paper was to present some of the lesser known factors and some of the situations which may be health hazards, in order to furnish the listener with a partial check list for future consideration of the problem.

Among the problems discussed were compressed gases, chemicals that cause dermatitis or skin burning, melted lead, radiation from welding, carbon monoxide, cutting oils, paints, fluorescent lamps, etc.

SANITARY DISTRICTS

A Panel Discussion was presented with **Edwin R. Cotton,** Exec. Engr. Comm. on Potomac River Basin, acting as Moderator. The papers presented on this panel covered such phases as organization and financing, and the operation of public authorities. Because of the limited space to be devoted to this meeting report, these papers will be reviewed here by title only.

"PROCEDURE FOR ORGANIZING SANITARY DISTRICTS" by Alvin Pasarew, Dir., State Planning Commission, Baltimore, Md.

"FINANCING PROJECTS" by N. L. Smith, Chief Engr., Dept. of Public Works, Baltimore County, Md.

"PUBLIC AUTHORITIES IN PENNSYLVANIA" by J. R. Hoffert, Chief Engr., State Health Dept., Harrisburg, Penna.

DISTRIBUTION SYSTEMS

"LOOKING AT A DISTRIBUTION SYSTEM" was the title of a panel discussion presided over by Moderator David V. Auld, Supt. Water Div., District of Columbia.

System Design

"SYSTEM DESIGN, PRACTICES, AND PROCEDURES" by R. L. Orndorff, Asst. Supt., Water Div., District of Columbia.

Mr. Orndorff described the District of Columbia distribution system and its four pressure zones and how efforts had been made to reduce dead ends, bottle necks, and small mains, and replace old and inoperative valves and services. For work of this type the water department should have a master plan to avoid a haphazard program.

Maps

"APPLICATION OF MAPS TO SYSTEM PLANNING" by J. B. Allen, Civ. Engr., Water Div., District of Columbia.

Mr. Allen showed samples of the types of map records used in the District, and pointed to the need for clear, accurate and reproduceable maps for both large and small areas. It is planned to put the Water Division's maps on microfilm.

Increasing Operating Efficiency

"OPERATIONS TO INCREASE EFFICIENCY OF EXISTING SYSTEMS" by J. R. Mitchell, Operating and Maintenance Engr., Water Division, District of Columbia.

Drawing on the experience of the District's water division, Mr. Mitchell

Programmers

T. M. Niles
Partner
Greeley & Hansen
Chicago, Ill.

G. L. Hall
Ch. Engr.
Md. Dept. H'lth
Baltimore, Md.

J. R. Hoffert
Ch. Engr.
Penna. Dept. H'lth
Harrisburg, Pa.

I. M. Glace
Cons. Engr.
Harrisburg
Penna.

S. K. Love
Chief
Water Qual. Div.
U.S.G.S.
Washington, D.C.

A. P. Black
Head
Dept. Chem.
Univ. Florida
Gainesville, Fla.

showed how studies on flow measurements had made it possible to schedule cleaning and relining operations which had greatly increased the carrying capacity of mains and decreased pumping costs and loss of head.

Such studies have also shown the location of bottlenecks in distribution systems. Leak surveys also cut the cost of pumping unaccounted-for water. It is quite general to save more in operating costs by eliminating leaks than the cost of leak surveys.

SHORT COURSES

A panel discussion was held on the subject "Benefits of Short Course Schools for Management and Operators." Prof. J. C. Geyer, Prof. of Sanitary Engineering, Johns Hopkins University, Baltimore, Md., acted as Moderator.

C. A. Hechmer, Dept. Eng. Wash. Sub. San. Dist., Hyattsville, Md., spoke on the success of the short course held at the University of Maryland last summer. Whereas a registration of 50 was expected, the actual registration was 101. Consensus of the students was that the course was too short. Mr. Hechmer feels that such a course should be held on a university campus and that it should be maintained on a serious level.

I. M. Glace, Cons. San. Engr., Harrisburg, Penna., presented comments on the "Importance of Participation by Municipal and Private Officials and Operators". Mr. Glace, who has been active in short courses in Pennsylvania for many years, knows whereof he speaks when he pleaded for "getting" the small water works man into a water works group. Short courses are the best road to establishing such an interest. Short courses build morale, raise the level of the operator and help him grow.

G. L. Hall, Chief Engineer, Md. State Dept. of Health, spoke on "The Future of Short Course Activities in Relation to State Health Departments." Mr. Hall emphasized the importance of such schools in raising the level of operation of water and sewage works, and improving the status of the operator, both desirable goals from the point of view of health departments.

A. H. Cline, Operator, Water and Sewage Treatment Plant, Agricultural Research Center, Beltsville, Md., presented some "Reflections and Comments on Short Course Schools". Mr. Cline spoke from the point of view of one who had attended the recent short course. Also appearing on this part of the program were four non-scheduled operators who had also attended the short course and spoke about their experiences. All of them were enthusiastic about the benefits of short schools.

Entertainment

Repeating the very popular feature held two years ago, the hosts (Washington's Water Supply Personnel) held an Oyster Roast at the Dalecarlia Filter Plant, where more than 130 persons had their fill of oysters, done to a turn and served by the water filtration plant crew.

An inspection of the plant was also on the docket. The Dalecarlia plant was using chlorine dioxide at the time. One of the new features is a chlorine residual recorder of which there will eventually be six located throughout the plant and system to give complete control of the water supply chlorination.

The annual banquet was preceded by a cocktail hour through the courtesy of the Water and Sewage Works Manufacturers' Assn.

Glossary of Water & Sewage Terms Still Available

It is our understanding that the Federation of Sewage Works Assns. still has available a number of copies of the "Glossary, Water and Sewage Control Engineering." This is the book published jointly last year by the A.P.H.A., A.S.C.E., A.W.W.A., and F.S.W.A.

Work on the glossary began in 1936 and culminated in 1947 in this joint effort on the part of these four associations. A limited edition was brought out and most of the copies have now been sold by the participating organizations.

For those not familiar with the Glossary, we should like to point out that from the beginning with the term "Abandonment" to the end with the term "Zooglea," each definition appears under the most important noun that can be selected. "When common usage would lead a person to look for a term under words other than a noun, that term also appears, with proper cross reference. . . . Since most of the definitions apply equally in the field of sewage treatment and water treatment, the word 'liquid' has been used to designate either water or sewage."

This book is definitely a glossary and not a dictionary and hence it does not say that the word "supernatant," for example, is an adjective and not a verb or a noun, although this is apparent from the use. The word "decant" which is gaining in popularity as a term for supernatant liquor, and the withdrawing of supernatant liquor, is not included; but you can find such words as katamorphic, xerophreatophyte, pellicular, chalybeate, saucisse, phreatic, Cauchee's number, ogee, and all of the common terms.

In 270 pages approximately 3500 terms are included. Copies of these books may be obtained from the secretary of any of the four associations of which you may be a member. Paper bound copies are available at $1 each. Cloth bound copies are $2 each. This is one book that every water and sewage works plant should have in its library.

MEASURING THE STRENGTH OF SEWAGES AND TRADE-WASTES B.O.D. or O.C.?

by

R. S. INGOLS
Ga. Inst. Technology*
ATLANTA, GA.

J. C. HILDEBRAND
Ga. Inst. Technology*
ATLANTA, GA.

G. M. RIDENOUR
Univ. of Michigan**
ANN ARBOR, MICH.

THE effect of sewage or industrial wastes in depleting the dissolved oxygen content of the receiving body of water is generally accepted as the most direct index of the strength of the sewage. In determining this strength, the analyst, as the result of experience and research during the last several decades, has had his choice narrowed to two separate and distinct tests. The oxygen consumed (O.C.) method, utilizes chemicals to estimate the amount of organic matter present, i.e., the carbonaceous oxygen demand of the sewage. The other test employs bacteria, measuring their oxygen requirements, and is commonly referred to as the biochemical oxygen demand (B.O.D.) technique. As will be developed in this paper, each of these procedures has its advantages and disadvantages, so that every thoughtful investigator in the field of sewage and industrial waste has been, at one time or another, confronted with the need for a decision as to which of these tests to employ.

The O.C. Test

The O.C. method, which derives its name from the fact that the results obtained are expressed (usually in parts per million, ppm.), in terms of the oxygen consumed by a sewage sample, is the older of the two procedures. Although potassium permanganate was for many years the principal reagent used in this technique, a number of other oxidants, including dichromates, iodates, and chlorine have also been employed.

Use of the dichromate ion was first described in 1926 by Adeney and Dawson[2], with a modification to their procedure being published the following year by Abbott[1]. Although these tests were not widely accepted by American investigators, they form the basis of a method described by Rhame[10] in the May, 1947, issue of *Water & Sewage Works*, in which the sewage sample was digested with an acid dichromate mixture for a short period at approximately 170°C. in the absence of water. The results of using a slight modification of Rhame's method on a large number of samples of sewage and industrial wastes has been published by Madison[10]. This particular investigation is of considerable interest as the values obtained were compared with B.O.D. values for the same samples. One disadvantage to the procedures of both Rhame and Madison is that no refluxing is used during the digestion period; the results of experimental work carried on in the senior author's laboratory indicate that some volatile organic matter is lost during such a digestion.

One major problem in the use of the acid dichromate O.C. test for determining the organic matter present in sewage is the fact that any chloride ions present will be oxidized to chlorine. In the methods of Adeney and Dawson and of Abbott, the chloride ions were removed by evaporating the sample in the presence of sulfuric acid until fumes are noticed. However, it has been shown by Ingols and Murray[7] and Moore, Kroner, and Ruchhoft[8], who presented their techniques almost simultaneously, that this problem can be overcome by determining the amount of the chloride ion present in the original sample and applying an appropriate correction to the final results.

Each of these last two methods uses a mixture of acid reagent and sample such that a digestion temperature of 145°C. is obtained during a 1-2 hour period of refluxing, and each determines the residual amount of unreduced dichromate. This value, of course, is subtracted from the total amount of dichromate used in the test. However, the two methods differ in the composition of the reagents employed. Moore, Kroner and Ruchhoft used pure sulfuric acid plus a standard aqueous solution of potassium dichromate. Because of the inclusion of the pure sulfuric acid an anti-bumping agent, such as pumice, must be employed. Ingols and Murray overcame the bumping with an equi-volume mixture of sulfuric and phosphoric acids in which solid potassium dichromate was dissolved. In addition, a selenium catalyst was employed. The inclusion of the phosphoric acid required the use of a volume of sample which was less than that of the acid mixture, primarily because of the lower boiling point of the phosphoric acid.

In a personal communication the catalytic role of selenium in this reaction has been contested by Dr. Madison of the Mellon Institute for Industrial Research, wherein he points out that the selenium is oxidized by the dichromate to selenium dioxide which in turn only partially oxidizes the iodide ion. The partial reduction of the selenium will, therefore, appear to increase the amount of organic matter oxidized. Thus, too much selenium gives an extremely high apparent concentration of organic matter, which of course is incorrect. In consequence it is recommended that the selenium be omitted entirely from this procedure. This, in addition to facilitating the reading of the end point of the reaction, will result in increased accuracy.

In 1941, Johnson and Halvorson[6], described an O.C. method in which the iodate ion was used as the principal oxidant. This method has been tried in the senior author's laboratory, but was found to be less accurate than the dichromate technique. In addition, the iodate method could not compete in ease of handling. However, Roy Weston of the Waste Control Laboratory of the Atlantic Refining Co. states in a letter that he has found the iodate procedure to be more satisfactory in analyzing wastes from the refining of petroleum and has, therefore, recommended it to the Committee on the Disposal of Refinery Wastes of the American Petroleum Institute.

The principal advantages of the new dichromate O.C. methods are that they are rugged, rapid, reasonably accurate, free from the interference of biological variations, and capable of producing results which can be readily reproduced with most of the organic constituents likely to be found in sewage and in many industrial wastes. Because of the need for quick results, O.C. methods are now being widely used, particularly for control

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purposes at sewage or industrial waste treatment plants.

However, results obtained by these methods fail to include some substances, e.g. alcohol and acetic acid. At least one other disadvantage is that it is not possible through the use of such methods to differentiate between those portions of organic matter that are available to bacteria and those portions which are unavailable. Rhame[10] has recommended the removal of paper from a sample before determining the O.C., in order to at least partially eliminate inert organic matter.

The B.O.D. Test

The B.O.D. procedure for the determination of the strength of a sewage sample had its real beginning in 1910 with the development of the Winkler method[20] for the rapid chemical determination of dissolved oxygen (D.O.) in water. By the use of this method, the effect of various amounts of organic matter upon the D.O. content of a sewage sample diluted with water could be followed directly. By 1920, Theriault[20] had developed the technique of the "excess oxygen" method (dilution technique) to the point where it was soon in wide usage, with the result that data from many tests for the B.O.D. of sewage began to appear in the literature.

Because the B.O.D. method cannot be used under all conditions, its short-comings served to stimulate developmental work in the O.C. field, and, as a result, many more papers concerning O.C. methods have been published since 1920 than were published during a like period prior to that date. A tremendous amount of work has also been carried out in developing modifications to Theriault's original method, many of the changes being proposed for the purpose of enabling investigators to obtain more accurate and reproducible results. Nevertheless, a number of serious limitations to the use of B.O.D. techniques still remain, as will be recounted.

As presently used, the determination of a regular B.O.D. value requires an incubation period of five days. Thus, this method is of limited value for control purposes in sewage or industrial waste treatment operations. The five-day incubation period is the shortest time that will yield reasonably reproducible results. The five-day period has also been chosen because it is the longest incubation period which will generally include only the carbonaceous oxygen demand. It is generally conceded that it is the carbonaceous, or "first stage," oxygen demand that creates the most damage to the receiving bodies of water. The rate of oxygen depletion during the nitrification stage is much slower and is much more dependent on the dissolved oxygen level than is carbonaceous degradation, the latter being able to proceed even under anaerobic conditions.

Seeding

The analysis of a sewage containing an industrial waste, or the determination of B.O.D. values for a separate industrial waste, is complicated by the fact that many organic substances are present which are not immediately available to bacteria. However, such substances may eventually become available in a stream through the development of an enzyme system in a portion of the bacteria already present, or through the development of new bacterial strains. Inasmuch as the development of neither an enzyme system nor a new strain of bacteria normally occurs within the five-day incubation period of the B.O.D. technique, results obtained by this method may not be truly indicative of the organic matter content of the sample in question. The same difficulty is encountered in attempting to determine B.O.D. values for such relatively pure compounds as glucose. As a matter of fact, the development of a satisfactory "seed" material which will overcome this limitation is one of the current major problems found by research workers in the sewage and industrial waste field.

Incubation Period

In a recent article in this magazine Rhame[10] suggests breaking away from the standard five-day incubation period and uses three-and six-day B.O.D. average values to calculate the ultimate first stage B.O.D. value and the first stage velocity constant of a large number of sewages. He shows velocity constants that vary from 0.05 to 0.41, but his average ultimate B.O.D. values and O.C. values by his earlier technique[19] are in excellent agreement when the dilution water is seeded and are in fair agreement on the averages of many other samples with unseeded dilution water. One cannot calculate the five-day B.O.D. for any one sample even when the ultimate value for the first stage B.O.D. is known, for the velocity "constant" is so highly variable. Rhame shows that the factor, for the five-day B.O.D. varies from 44 to 99 per cent instead of the average 68% of "Standard Methods" [20].

Incubation Temperature

Any biological oxidation is affected by temperature, so that the rate of the B.O.D. reaction is strongly dependent upon the incubation temperature. However, the standard B.O.D. test[10] is run at 20°C. For many years, it was thought that the ultimate carbonaceous oxygen demand of sewage was a function of temperature, but Gotaas[3], in a recent, complete study of the temperature effect, has shown that this is not the case. According to his results, the rate and the onset of bacterial activity (carbonaceous and nitrifying) is greatly retarded at low temperatures in the dilution technique.

Dilution Water

The chemical composition of the dilution water used in the B.O.D. technique has a distinct effect on the results obtained[9]. For example, in order that reasonably similar results may be obtained by two different laboratories when using identical procedures to test even such a common substance as sugar, all of the necessary mineral substances must be available in the dilution water in each instance. In the analysis of actual samples of sewage or industrial wastes, it would be desirable for many reasons to utilize the receiving lake, stream etc., as a source of dilution water; however, in view of the wide differences in the composition of such waters, even in samples taken from varying locations on the same lake or stream, such a practice is obviously impracticable. Therefore, it has become customary to use distilled water fortified with those elements not directly involved in the utilization of oxygen, but which are necessary for the formation of new protoplasm. Thus, the addition of sodium, potassium, phosphate, ammonia, calcium, chloride, magnesium, and sulfate is quite essential[20] if one is going to obtain a growth of bacteria in such a material as pure sugar[20].

However, the extent to which dilution water should be fortified is governed by the material being analyzed; sewage contains all of the elements referred to above, but the analyses of many industrial wastes approximate the chemical characteristics (deficiencies) of a solution of pure glucose. Thus, citrus juice canning plant wastes contain only 10-20 per cent of their requirement of nitrogen and phosphorous. Phosphates in particular also aid in the control of the pH of the sample during incubation and maintain the reaction in an optimum range for the activity of the bacteria which are actually utilizing the oxygen.

Toxic Materials

The presence of certain toxic materials may interfere with bacterial

activity and, thus, invalidate the results of B.O.D. tests. Such materials may be present in the original sample or may be inadvertently added in the dilution water. As an example of the latter type of error, copper salts could enter the dilution water if copper tubing is used for carrying the distilled water from the still to a storage bottle or to the dilution bottle.

Nitrification Stage

One further complication in the B.O.D. test is the fact that the value obtained may include oxygen required to nitrify the ammonia present in addition to that required by the sample's organic matter content. In general, ammonia is not nitrified during the first five days of incubation, but, as has been shown by Heukelekian[9], a high inoculation of those organisms which can oxidize ammonia will result in the obtainment of a five-day B.O.D. value that includes the oxygen demand of nitrification. Further, Ruchhoft, et. al.[10], indicate that B.O.D. sample bottles having a relatively low concentration of sewage have an earlier onset of nitrification than those of greater concentration.

The type of seeding for treatment plant effluents has assumed considerable importance recently, because it was felt that the nitrifying flora of the trickling filter or of the activated sludge floc was being given off in sufficient quantities to change the time of onset of nitrification in an effluent sample. In order to make the B.O.D. value of an effluent comparable with that of an influent, modifications have been proposed by Sawyer and Bradney[11] and by Hurwitz, Barnett, Beaudoin, and Kramer[9]. In each of these, the non-spore formers, or nitrifying organisms, are killed, after which the effluent is then reseeded with a sample of raw sewage. The B.O.D. values of the effluent will then be an indication of the amount of organic matter still remaining and available to the bacteria. However, if the raw sewage used for the seeding purposes has a high content of nitrifying organisms, the whole purpose of the modified procedure will be defeated. The two modifications differ only in the method used to kill the nitrifying organisms; Sawyer and Bradney pasteurized the sample, while Hurwitz, et. al., used an acid to accomplish this.

Another approach to the problem of controlling the onset of nitrification has been suggested by Placak, Ruchhoft, and Snapp[12], who have obtained data which indicate that a two ppm. chromate ion concentration will control or completely retard the activity of the nitrifying organisms. The beneficial effects of this ion would continue throughout the incubation period; therefore, the results obtained would not be affected either by the presence of a high nitrifying flora content in the sewage to be used for reseeding, or by the dilution of the sample in the incubation bottle.

Table I

A Study of the Dilution B.O.D. Values of Starch and Dextrose

Substance	Concentration Used	Theoretical Oxygen Demand		B.O.D.	
	ppm.	Total ppm.	5 day ppm.	Av. Exp. Values ppm.	Ratio of Exp. to Theo. Values (%)
Dextrose	200	214	146	130	89
Starch*	200	237	161	40	25
Starch**	200	237	161	110	67

*Normal sample of sewage used as seed.
**Using a special seed developed for this test.

In summary

In summary, it might be said that the B.O.D. test is slow; that nitrification may or may not occur during the incubation period; that the dilution or concentration of the sample during the incubation period may affect the values obtained; that the composition of the dilution water in the analysis of industrial wastes is intricate; that obtaining a proper seed may be difficult; that the velocity of the oxygen utilization in typical sewage samples varies greatly during the usual five-day incubation period; and that care must be used to exclude toxic substances. However, it should also be noted that some authorities in the field of sewage analysis continue to feel that the B.O.D. test provides the only real method for determining the strength of a sewage or of an industrial waste. This feeling, of course, is based on the fact that the B.O.D. value reports only that portion of the organic matter that is available to the bacteria, but this in itself may be a weakness as well as a virtue.

Table II

A Study of the Effect of Anaerobic Storage Upon Settled Sewage

Time of Storage (Hours)	B.O.D., Duplicate Runs (ppm.)	
	Set A*	Set B*
None	150 ± 1.0**	150 ± 1.0**
3	152 ± 1.1	160 ± 0.6
7	119 ± 1.9	155 ± 1.2
24	145 ± 1.3	148 ± 1.4
31	147 ± 2.8	154 ± 2.1
48	127 ± 0.6	127 ± 0.6
73	96 ± 2.2	123 ± 3.4
225	146 ± 1.1	

*Each value is the average of the results from five individual bottles.
**Probable error of the mean.

From the preceding, it may be readily seen that the B.O.D. and O.C. tests are not always based on the determination of the same organic matter, e.g., O.C. results include the concentration of such items as paper, which is not available to either stream or test bacteria, while the presence of certain toxic materials will affect the results of the B.O.D. test, but not those obtained by the O.C. procedure. Thus, a thorough understanding of the capabilities and limitations of each test must be acquired prior to attempting either to interpret B.O.D. results or to evaluate the relative importance of the results obtained by either test.

Experimental Work

In the following paragraphs a series of data obtained in the authors' laboratory will be presented in an effort to show (1) the adaptability of sewage organisms to typical conditions used in the B.O.D. dilution technique; (2) the adaptability of sewage organisms to naturally occurring foods such as sugar and starch (although it is recognized that such foods are not normally found in domestic sewage); (3) the adaptability of organisms from a number of sewage samples to the use of nitrate oxygen during incubation; (4) the effect of anaerobic storage upon a sample prior to its analysis by the normal dilution technique; (5) the effect of blending of a large number of samples of raw sewage upon the B.O.D. and the O.C. values; (6) the precision and accuracy of the dichromate and permanganate O.C. techniques.

In all of the work on the B.O.D. dilution technique reported herein, the dilution water was prepared in accordance with the directions contained in the ninth edition of "Standard Methods"[13]. All tests for the presence of copper and chlorine were completely negative, and in each instance the samples were pipetted directly into the sample bottle, after which the dilution water was siphoned directly from the dilution water bottle into the sample bottle, except in the analysis of pure organic substances where seeded dilution water was employed.

All O.C. tests were run by one or both of two methods: the permanganate procedure described in "Standard Methods" and the dichromate technique of Ingols and Murray[6].

Adaptability of Organisms

The adaptability of sewage organisms to typical conditions encountered

in the dilution technique can best be shown by an analysis of the results obtained from a study of the rate of the B.O.D. reaction. A large number of samples were analyzed, with wide variation in the results from single runs, as shown in Fig. 1. However, it should be noted that each point plotted on the two curves is the average of at least four B.O.D. sample bottles. The very long lag period noted in the lower curve of Fig. 1 probably explains the difficulties which are frequently encountered in attempting to obtain reasonably good B.O.D. values from sewage samples when short incubation periods are used.

In the substitution of the values of the B.O.D. results shown in the lower curve of Fig. 1 into the formulae of Rhame [10], it was found that no velocity constant could be calculated because the three-day value (from the curve) was less than half the six-day value. When the three-and six-day values from the upper curve are employed in the Rhame formulae, the calculations give a velocity constant of 0.25, which is high but less than the maximum reported by Rhame [10]. Rhame further indicates that better five-day B.O.D. values can be obtained with sewage when the organisms are obtained from two sources; i.e., when seeded dilution water is used. However, there is still a wide variation in velocity constants with the seeded water, and the average value for the velocity "constant" is higher when seeded dilution water is used.

In studying the adaptability of sewage organisms to starch, it was considered desirable to obtain both O.C. and B.O.D. values for the same samples. By noting the data presented in Table I, it may be seen that the B.O.D. values were not too accurate. In the first experiment with starch (Line 2), the seed used was completely inadequate; therefore, the concentration of the seeding material was then increased until there was at least a 50 per cent depletion in the D.O. remaining in the control at the end of a five-day period. However, even with this high depletion of the D.O. in the control, the B.O.D. of the starch did not increase, the five-day value of the B.O.D. being only about 25 per cent of the theoretical. This low recovery value seemed to indicate the need for a special seed; after this was developed and used, an appreciably better recovery of the B.O.D. of the starch sample was obtained (Line 3). However, even though a special seed was used, the results obtained for starch did not approach either the theoretical percentage or the value which was obtained with a normal sewage to which glucose had been added as the pure substance.

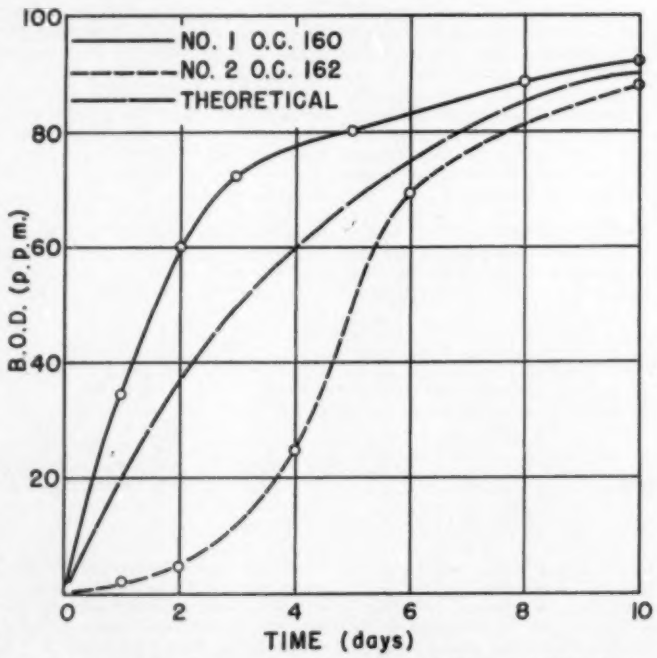

Fig. 1. A Comparison of Observed B.O.D. Values With the Theoretical B.O.D. Curve

The data used to determine the adaptability of sewage organisms to the use of nitrate oxygen during incubation were compiled by the senior author, and, inasmuch as a detailed description of this work is to be published elsewhere, it will be reviewed only briefly at this point. Suffice it to say that nitrates were used as a source of oxygen, such usage having been originally proposed by Lederer[19] in 1915 while determining B.O.D. values on sewage and on wastes from tanneries and slaughter houses. The inherent difficulties of determining the excess nitrate present were overcome by the use of a recording potentiometer and photoelectric cell set-up in conjunction with an indicator (methylene blue) to show the time of disappearance of the nitrate ion. The results obtained indicated that this technique is successful with some sewages but *not* with others. It was concluded from the results obtained that a large variation occurs in the flora of various sewage samples, even when collected from sewage plants in the same city.

Effect of Anaerobic Storage

In the study of the effect of short-time anaerobic storage upon B.O.D. results, settled sewage was used because this would yield samples having a maximum of uniformity. The settled sewage was divided into two portions, with each portion being used to fill completely a number of glass-stopper bottles. The B.O.D. value of each portion was determined (in quintriplicate) after the lapse of varying periods of storage, with previously unused bottles being tested in each instance. The data obtained from one such run are listed in Table II, and a study of these results indicates that there is a large variation in the B.O.D. of a sample which has been subjected to anaerobic storage. Study of these data, which, incidentally, are typical of the results obtained in a large number of runs, further indicates that the variations obtained exceed by a considerable amount the ten per cent variation which is generally accepted as the accuracy of the B.O.D. test.

Effect of Blending

The large variations which occur during the analysis of samples of raw sewage indicated that it might be desirable to homogenize raw sewage prior to attempting to determine its strength. When a large volume of material is homogenized in a Waring Blendor, the total organic matter of the blended material can be compared with the total organic matter of the the blended material can be compared

with the total organic matter of the raw sewage by means of the O.C. values of the respective samples. As shown in Table III, such values do not show any appreciable variation, although occasionally the blended sample may contain an appreciably larger amount of organic matter, as shown by Sample 14. However, the corresponding B.O.D. values *did* vary, with the blended values being lower than those for the raw sewage. Although much time was devoted to an attempt to find an explanation for this phenomenon, only inconclusive results were obtained.

Attention should be called to the fact that all of the samples listed in Table III were also analyzed by an outside laboratory for their B.O.D. values. As indicated by this table, the results of that laboratory's analyses and of the analyses carried out in the senior author's laboratory are not in agreement. Further, the results of the senior author's analyses of some samples, notably Nos. 18 through 23, are very much higher than the expected value, i.e., 68 per cent of the O.C. value, and, in addition, are two or three times as great as the results obtained by the other laboratory for the same samples. No positive explanation for the wide variances in manganate determinations is lower than those utilizing dichromate on substances such as sugar, and particularly on starch. The fact that the dichromate results for sewage were found to be subject to a wider variation than were those of the permanganate technique is apparently caused by the fact that the permanganate test determines predominantly the soluble factors present in sewage, whereas the dichromate procedure determines most of the organic matter present, including such items of suspended matter as paper. This series of experiments also revealed the fact that the phosphoric and sulfuric acid mixture used in the Ingols-Murray dichromate test is sensitive to light; i.e., the dichromate ion is reduced in sunlight to a very appreciable extent, and is completely reduced within a period of one week if allowed to stand in the open in a sunlighted laboratory. However, this problem can be solved very easily by storing the reagent in the dark.

Discussion

The addition of uncommon but readily available substances, such as sugar, to a sample of sewage or activated sludge requires an appreciable period of time for the adaptation of the bacteria. This was demonstrated by Ingols and Heukelekian[6], who showed that the first dose of glucose is used by activated sludge at an appreciably slower rate than the third dose. It is not surprising, therefore, that starch, even though a naturally occurring food, requires a special seed when added to sewage in a dilution B.O.D. analysis. Accordingly, if industrial wastes are going to be analyzed with any degree of accuracy, a special seed must be developed which is capable of attacking the organic matter at such a rate that the usual five-day incubation period of the B.O.D. test can be used. Alternately, the solution to this problem may lie in extending the incubation period from five to ten days, or by analyzing on two days, as recommended by Rhame[13], and then calculating an ultimate demand. Either of these alternative methods would require the use of larger amounts of equipment for the B.O.D. test, but use of one of them may be necessary in the end.

The fact that nitrate oxygen is more readily available to the flora of some sewages than it is to the flora of other sewages is of relatively little importance in a discussion of the dilution B.O.D. test. It does indicate, however, that the flora of sewage collected from different parts of the same city can vary quite widely in their characteristics. Thus, in setting up an analysis of an industrial waste, the data obtained with one sewage sample cannot necessarily be expected to agree with that obtained from another sample, even though both sewage samples were obtained in the same city.

It has been suggested by some investigators that sewage which is to be used as a seed in the analysis of industrial wastes be stored for 24 hours prior to use. It has been the senior author's experience that sewage may be more active the first day than the second, or vice versa. This factor of variability appears to be neither controllable nor predictable, regardless of whether the sewage is stored under aerobic or anaerobic conditions, according to results obtained by the authors (Figure 1 or Table II). The fact that a second source of seed is used may be more important than the age of the seed.

As indicated previously, no reason can be offered which would explain why the B.O.D. values for blended (homogenized) sewage should be lower than the corresponding values for the unblended material. It was at one time thought that the reduction of the discrete surfaces in the raw sewage by blending caused the lower B.O.D. values of the homogenized sewage, because experiments on the addition of glass wool to sewage samples caused a very large increase in B.O.D. values, particularly at low sewage concentrations. However, this increase in B.O.D. values was traced to two sources, the major one of which was the presence of food (in the form of a lubricating soap) on the glass wool. The other source, which was responsible for but a small portion of the increased value, proved to be stimulation of the nitrifying flora from the dilution water. On the basis of the O.C. values, no reduction in organic

Table III

A Study of the Effect of Blending Raw Sewage Samples

Sample No.	Oxygen Consumed (O.C.)		Biochemical Oxygen Demand (B.O.D.)		
	Raw	Blended	Raw	Blended	Outside Lab.
	ppm.	ppm.	ppm.	ppm.	ppm.
1	333 ± 15.5	325 ± 11.3	172 ± 4.1	174 ± 2.5	94
2	333 ± 18.4	317 ± 4.2	170 ± 8.7	172 ± 8.4	104
3	425 ± 14.2	399 ± 19.8	193 ± 18.9	204 ± 13.4	154
4	384 ± 36.9	368 ± 14.1	222 ± 65.5	107 ± 7.9	104
5	189 ± 12.7	213 ± 7.0	66 ± 6.0	51 ± 8.6	40
6	324 ± 1.4	327 ± 10.0	175 ± 23.8	183 ± 9.0	135
7	294 ± 0.0	291 ± 14.1	136 ± 13.3	135 ± 7.6	109
8	342 ± 0.0	376 ± 11.3	192 ± 17.9	201 ± 13.3	129
9	290 ± 24.0	320 ± 14.1	126 ± 9.6	111 ± 6.4	115
10	345 ± 49.2	309 ± 15.5	146 ± 10.2	130 ± 7.4	63
11	300 ± 14.1	302 ± 2.8	135 ± 5.0	128 ± 4.6	64
12	411 ± 29.6	373 ± 19.6	211 ± 29.4	199 ± 9.6	149
13	320 ± 22.6	333 ± 8.5	144 ± 10.3	144 ± 107	110
14	341 ± 15.5	528 ± 16.9	185 ± 7.6	312 ± 16.1	130
15	442 ± 4.2	442 ± 8.5	267 ± 23.8	217 ± 9.8	153
16	417 ± 29.6	434 ± 25.4	270 ± 27.1	213 ± 12.9	171
17	549 ± 46.6	490 ± 41.0	500 ± 22.6	315 ± 48.0	116
18	338 ± 7.0	333 ± 0.0	496 ± 41.0	382 ± 59.0	86
19	384 ± 4.2	439 ± 18.4	360 ± 17.6	311 ± 60.3	85
20	356 ± 9.9	367 ± 7.0	386 ± 40.5	381 ± 64.6	89
21	388 ± 36.5	349 ± 9.9	266 ± 34.5	301 ± 5.2	100
22	435 ± 26.9	392 ± 7.0	398 ± 31.2	401 ± 59.5	94
23	298 ± 14.2	282 ± 17.0	336 ± 62.0	324 ± 62.0	29
Avg.	358 (± 19)*	361 (± 17)*	241 (± 23)*	225 (± 22)*	105

*These values are the average of the probable error of each individual value, not the probable error of the overall average.

the B.O.D. values obtained in the two laboratories can be offered.

Data shown in Table IV, which deals with the accuracy and reproducibility of the permanganate and dichromate O.C. techniques, were obtained by using substances such as starch in addition to sewage samples. These data indicate that the permanganate procedure yields results which are more reproducible than those obtained by the dichromate method, with sewage, but that the accuracy of per-

matter occurred during blending, and on four or five samples which were tested there was an increase, rather than a decrease, in the relative number of bacteria present. This latter phenomenon was apparently caused by the breaking up of clumps of bacteria during the blending operation.

In the presentation of the O.C. and B.O.D. values obtained from the same sewage samples, it was inferred that the O.C. values were correct and that the B.O.D. values were too high. In the absence of a true standard, it might just as well be postulated that the B.O.D. values were correct and that the O.C. values were too low; however, in view of the B.O.D. values obtained from an outside source, it was assumed that the O.C. values more nearly represented the true conditions. Two explanations, each of which will be discussed in some detail, may be offered for this phenomenon. One is that the samples were collected during a period when the level of the ground water in this area was unusually high, while the other lies in the method employed to clean the glassware used in the various tests.

During the period in which the samples which ultimately yielded the very high B.O.D. values were collected, there was a great deal of rain; therefore, there was an unusually high sewage flow caused by ground water infiltration. Inasmuch as many surface well waters in this area have nitrate ion concentrations of five ppm. or higher, it is conceivable that the inclusion of ground water in the samples caused an increase in the number of nitrifying organisms present, and that these organisms advanced the onset of nitrification. These samples were run and the data recorded until sufficient information was obtained to make an appraisal worthwhile. Unfortunately, by the time such an appraisal was made, and it was realized that the wet weather might be the cause of the high values, the period of inclement weather had ended.

As to the second possible explanation of the high B.O.D. values, it may be stated that the acid-dichromate mixture which is widely used for cleaning glassware was used for many months in the senior author's laboratory. However, as has been mentioned before, Placak, Ruchhoft, and Snapp[8] showed that a concentration of two ppm. dichromate ion is toxic to nitrifying organisms. Therefore, inasmuch as it was felt that adsorbed dichromate ions might be retarding the onset of nitrification in the sample bottle, pure sulfuric acid was substituted for the acid-dichromate mixture previously used for the final washing of the sample bottles. Whatever the reason, the very large increase in the relative ratio of B.O.D. to O.C. values was wholly unexpected; unfortunately, it has since been difficult to obtain sewage samples having a high ground water content in order to prove or disprove either explanation. As a matter of interest, when sewage collected during a dry period was used, the method of cleaning the glassware had no effect upon the B.O.D. values.

Table IV

A Study of the Accuracy and Precision of the Permanganate and Dichromate O.C. Tests*

Sample	O.C. Method	Theoretical O.C.	Results: Average	Precision "S"	Precision CIx 95%	Accuracy
		ppm.	ppm.	ppm.	ppm.	per cent
Starch	Dichrom.	237	208	4.0	2.9	88
Starch	Perman.	237	77	1.8	1.3	33
Starch	Dichrom.	237	220	5.4	2.9	93
Starch	Perman.	237	64	3.9	.....	27
Sewage No. 1	Perman.	.....	76	2.5	1.8	.....
Sewage No. 1	Dichrom.	.....	444	52.	37.	.....
Sewage No. 2	Perman.	.....	72	1.2	0.8	.....
Sewage No. 2	Dichrom.	.....	342	20.	14.6	.....
Sewage No. 3	Perman.	.....	83	1.0	0.7	.....
Sewage No. 3	Dichrom.	.....	460	14.	1.0	.....

Sewage No. 1—5 day B.O.D., 175 ppm.
Sewage No. 2—5 day B.O.D., 200 ppm.
Sewage No. 3—5 day B.O.D., 189 ppm.

*Ten samples in each average value.

In Retrospect

A research worker has a very heavy responsibility in the presentation of experimental data. Frequently, such a worker has two choices. One is to take averages of the data obtained and to draw very conservative conclusions from them. The other is to decide that there are so many variations from the average that only the extremes in the data should be presented, thus showing the maximum variations which have occurred and which may thus be expected in the work of others.

Obviously, the latter course has been selected by the authors in the presentation of the above data on the B.O.D. test. In doing so, they are not unaware of the valuable information which has resulted from the use of this test for the records of sewage treatment plant operations and in the design of new facilities. However, this paper has been prepared for the purpose of pointing out the dangers that are involved in using the values from any one or several B.O.D. tests, for, while most workers are aware of the many variabilities which may occur in the B.O.D. test, all too many prefer merely to ignore values which deviate too far from the mean and to gloss over the difficulties inherent in the test. One example may be cited as typical—one sanitary chemist, upon being shown the data contained in Table II, remarked that the one value of 119 ppm. B.O.D. shown for seven hours of storage should be discarded (in spite of the fact that it is statistically significant as the average of five bottles), and that it was the habit and custom in his laboratory to disregard all data which deviated from a majority of the data obtained. As a matter of fact, the authors admit that the B.O.D. of 119 ppm. is worthless as an index of the strength of that sample, but, had that been the only value obtained on that sample, how would the analyst have known?

When a well established test is even partially discredited, it is obvious that a substitute must be available or developed. It is not the intention of the authors to recommend that the B.O.D. test be discarded, but it is their feeling that the results of such tests be evaluated very carefully in the light of O.C. values obtained on that sample either by the technique of Ingols and Murray[7] or that of Moore, Kroner, and Ruchhoft[8]. O.C. values will provide a better basis for understanding the results of B.O.D. tests and at the same time will permit an evaluation of some of the possible difficulties encountered with the B.O.D. test, such as the use of insufficient quantity of seed, unavailability of a large percentage of the organic matter, the presence of toxic materials, or the degree of nitrification.

Some chemists and sanitary engineers believe that the results of the B.O.D. and O.C. tests should not be compared, because the O.C. test indicates only the total carbon, not the available carbon, while the B.O.D. test measures the oxygen demand of the carbon, nitrogen, and sulfur. The purpose of both the five-day incubation period and recently proposed modifications of the B.O.D. procedure are directed toward eliminating the oxygen demand of nitrification. The sulfur demand will be important only in a limited number of samples. The removal of paper from sewage modifies the sample to such an extent that the O.C. value indicates predominantly the same carbonaceous material as determined by the B.O.D. It seems to the authors that much more can be

learned about the sewage or industrial waste sample from a careful comparison of the O.C. and B.O.D. values than can be learned from either test alone.

Acknowledgement

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N. Y. Breaks Ground for New Sewage Works

On Nov. 7, Hon. William O'Dwyer, Mayor of New York City, officiated at the ground breaking ceremony for the $25,000,000 Hunts Point Sewage Treatment Works in the Bronx. Presiding at the ceremonies was Frederick H. Zurhmulen, Commissioner of Public Works.

When the Hunts Point plant is completed, all raw sewage will be eliminated from the upper East River and Long Island Sound. The first six contracts which have been let total more than $15,000,000. The plant is designed to treat 120 mgd. from a tributary population of 770,000 persons in an area of 15,600 acres. The design provides for the future enlargement of the plant to a capacity of 150 mgd. from an estimated population of 961,000, a figure that is expected in 1970.

No industries of any size are located in the area, nor are any expected in the future. The short period activated sludge process will be used. Sludge will be digested, and the digested sludge will be barged to sea. Gas collected will be used to operate four gas engines producing 3600 hp.

Plans for the Hunts Point plant were drawn by Greeley and Hansen, Engrs., Chicago, under the direction of the New York Public Works staff headed by Richard H. Gould, Director; Wellington Donaldson, Asst. Director, Div. of Sewage Disposal, and William O'Leary, Chief, Bur. of Sewage Disposal Design. Operation of the plant will be under the direction of Nathan I. Kass, Chief, Bur., of Sewage Disposal Operations.

Carl Hechmer Passes

Carl A. Hechmer, Sr., Maintenance Engineer of the Washington Suburban San. Comm., died Nov. 24 in a Washington, D. C., hospital after a short illness. He was 54 years old.

Mr. Hechmer had been engaged in sanitary engineering work for 35 years, principally in the maintenance and operation of water and sewerage systems. He was a native of Baltimore, Md., and a graduate of the Baltimore Polytechnic Institute. Prior to going with the Sanitary Commission in 1918 he had been connected with the Baltimore City Water Dept. and the Engineering Div. of the Maryland State Dept. of Health.

Mr. Hechmer was an active member of a number of professional societies, being a past president of the Maryland-Delaware Water and Sewerage Assoc., a member of the American Society of Civil Engineers and at the time of his death was a Director of the American Water Works Assoc., representing the Chesapeake Section. Previous to the formation of the Chesapeake Section, Mr. Hechmer had served both as Secretary and as Chairman of its predecessor section, the Four States Section of AWWA. This Section selected Mr. Hechmer in 1940 for the George W. Fuller Award, a signal distinction. He also served some years ago as Chairman of the Plant Management and Operation Div. of the American Water Works Association and served on various committees of the Association.

The Short Courses for water works operators which are conducted by the Maryland-Delaware Water and Sewerage Assoc. are largely the result of the efforts of Mr. Hechmer, who had general supervision over them since their inception. He had an enviable ability for imparting knowledge to others and in this way contributed much to the discussions at meetings, as well as in lecturing.

The following is an excerpt from a letter written by Harry R. Hall, Chief Engr. of the Washington suburban Sanitary Commission, with whom Mr. Hechmer had been closely associated for thirty-three years.

"Aside from his professional ability, he endeared himself personally to most everyone who knew him. Those who worked under him looked upon him more as a friend than a superior, and he was always trying to do something to help his men in their personal troubles. His loss will be mourned sincerely; and, while places can always be filled, it will not be so easy to find another Carl Hechmer."

Yes, Carl Hechmer was one of those exceptional individuals of solid sterling qualities with which this water works profession is so richly blessed.—L.H.E.

CHROMIUM REMOVAL BY ION EXCHANGE

And Comments on the Chemistry of Chromium Complexes

by

DON E. BLOODGOOD* AUBREY STRICKLAND**

Purdue University
LAFAYETTE, INDIANA

SEVERAL methods for the disposal of chromium compounds have been reported [1] [2] [3]. Some of these methods have been said to be satisfactory for particular situations, but the removal of chromium compounds in dilute waste waters from the metal plating processes presents problems not yet satisfactorily solved. None of the processes reported are efficient or effective when judged from the standpoint of the production of chromium free water or the recovery of valuable chromium compounds. The methods used at the present time are:

(1) Reduction and precipitation with various compounds with subsequent disposal by dumping or burial, and

(2) Precipitation and partial recovery of the desired constituents by electrolysis.

Cognizance of the need for a method of eliminating toxic chromium from waste waters from metal plating plants prompted studies at Purdue University using ion exchange resins. Early attempts were made to treat metal plating wastes containing both chromium and cyanide compounds but it was ultimately concluded that the complexity of each was such that it was necessary to study the two wastes separately.

Typical Test

Experiments were conducted using commercial ion exchangers and the following is a description of a representative test.

A test solution was made up to contain potassium chromate (K_2CrO_4) in a concentration of 100 ppm. as $CrO_4^=$. The anion and cation exchanger beds were made up of resin grains of a size that were retained on a 30 mesh U. S. Standard screen. The resins were held in 3.1 cm. diameter glass tubes, the depth being 16.6 cm. with a bed volume of 125 ml.

The experiment was carried out by passing the test solution downflow through the cation exchanger, and then through the anion exchanger at a flow rate of 50 ml. per minute. Analyses were made on batch quantities of liquid passing through the beds. The anion effluent samples were analyzed for chromate by the standard iodometric procedure. Determinations for pH were made with a potentiometer.

The Senior Author

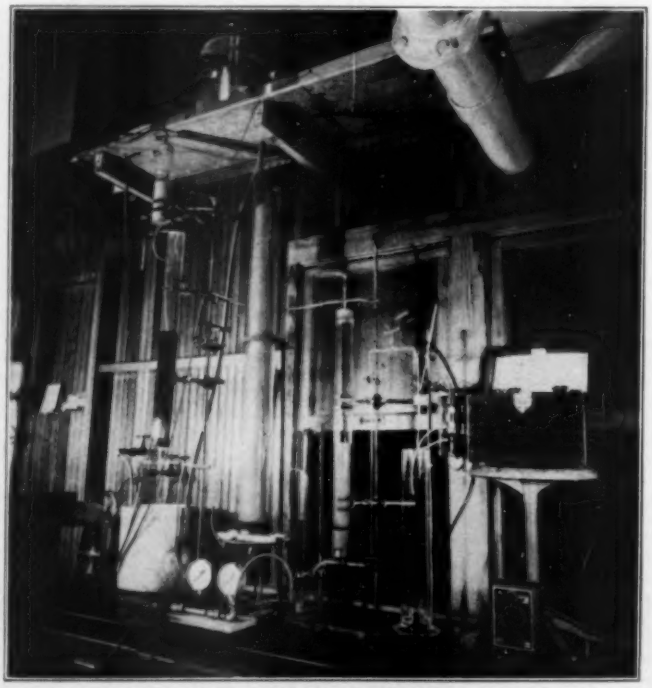
Results obtained in this test are shown in Table I. Of the 1550 milligrams of chromate added to the beds only 12.2 milligrams were found in the anion bed effluent. By difference there must have been 1538.8 milligrams adsorbed in the two exchanger beds.

Recovery from Exchangers

Attempts to recover the chromium from the exchanger beds were made, using sulfuric and hydrochloric acids on the cation exchanger bed, and sodium hydroxide and hydrochloric acid on the anion bed.

A summary of these operations and results is given in Table II.

From Table II it may be seen that of the chromate adsorbed in both beds, only 20.67 per cent was recovered, the



Laboratory Experimental Apparatus

*Prof. San. Engineering.
**Graduate Student.

The Junior Author at Work on the Chemistry of Chromium

rest remaining on the resins. A rather surprising result was that some of the chromate had been adsorbed by the cation exchange resin. It is presumed that the chromate was reduced to the trivalent chromic ion by the resin and adsorbed thereon. The resin particles became softer and smaller so it is assumed that the resins were oxidized to some extent by the chromate. This observation prompted studies with chromic sulfate and various commercial cation exchange resins to learn something of the removal of chromium in the trivalent state. It was realized that the chromate compounds normally found in metal plating wastes would have to be reduced to the chromic form if the chromium was to be removed on the cation bed. Tests were made to determine the best methods and reagents for elution of the adsorbed chromium. Various concentrations of sulfuric acid, hydrochloric acid, ammonium hydroxide, and tartaric acid were used for regeneration of the resins, and in none of the experiments was the chromium removed completely from the resin.

It appeared that both the chromate and the trivalent chromic ions formed stable complex compounds with the resins, making complete elution virtually impossible.

Since anion resins apparently adsorbed only anions, it was decided that it might be possible to reduce the adsorbed anionic chromate ions to the trivalent cationic chromic ion and elute it as such.

Static tests were made on two 10-gram (dry weight) samples of an anion resin. Into each sample of resin was pipetted 200 ml. of potassium chromate solution, each 200 ml. sample containing 6.023 milligrams of K_2CrO_4. After standing for 1½ hours the liquid was filtered off, and the resin samples were rinsed with distilled water, the rinsings being collected with the filtrate. Analysis of the filtrate samples by the diphenyl carbazide method showed that the effluents of each contained 0.0045 milligrams of K_2CrO_4. The per cent removal was 99.93 per cent.

One sample was treated with 2.0012 grams of sodium oxalate and the other with 1.9994 grams of sodium bisulfite, each in 200 ml. of distilled water. The samples were allowed to stand for 24 hours. The liquid was filtered from the resin samples and then each sample was rinsed with 200 ml. of distilled water, the rinsings being caught along with the filtrate.

Analysis by the standard iodometric method of the solutions from these regenerations showed that the regenerant from the oxalate regenerated sample contained 2.786 milligrams of K_2CrO_4, representing a recovery of 46.29 per cent, and the bisulfite regenerant contained 2.679 milligrams of K_2CrO_4, representing a recovery of 44.51 per cent. The resin samples did not show appreciable effects of oxidation by the chromate.

It has been learned that the reason for such low regeneration results was probably the formation of anionic chromic complexes with the excess of regenerating reagent and readsorption of these complexes.

Chemistry of Chromium

From the unsatisfactory results of the experimental work it became apparent that an extensive study of the chemistry of chromium would have to be undertaken before any logical explanations of the perplexing experimental results could be made.

Table I

(Exchanger "C")

Chromate Test Solution Contained 100 ppm. CrO_4=ion

Composition of Anion Effluent

Sample No.	Sample Volume Ml	Conc. CrO_4= ppm.	Wt. CrO_4 mg.	pH
1	1000	0.0	0	7.00
2	1000	0.0	0	7.00
3	1000	0.4	0.4	7.00
4	1000	0.4	0.4	7.00
5	1000	0.0	0	7.40
6	1000	0.4	0.4	7.20
7	1000	0.4	0.4	7.20
8	1000	0.4	0.4	7.20
9	1000	0.8	0.8	7.15
10	1000	0.8	0.8	7.35
11	1000	0.8	0.8	7.20
12	1000	1.6	1.6	7.20
13	1000	1.6	1.6	7.20
14	1000	1.6	1.6	7.20
15	1000	2.0	2.0	7.10
15.5	500	2.0	1.0	7.10
Totals	15,500		12.2	

Table II

Summary of Chromium Recovery Operations from Test of Exchanger "C"

	Treatment Downflow Application at 25 ml. per min. in each case	Effluent Color	Milligrams of Chromate (CrO_4)*	Percent* of Total Cr Available	Total Recovery Percent
Cation	500 ml. 2% H_2SO_4	Colorless	4.12	0.37	
	500 ml. 2% H_2SO_4	Colorless	3.34	0.22	
	200 ml. 1:1 H_2SO_4	Pale Green	10.45	0.68	
	1000 ml. dist. H_2O	Colorless	4.74	0.31	
	500 ml. 1:3 HCl	Yellow Green	2.17	0.70	
			24.82	2.28	2.28
Anion	500 ml. 1.5% NaOH	Yellow	166.0	10.85	
	500 ml. 1.5% NaOH	Yellow	51.3	3.35	
	500 ml. dist. H_2O	Pale Yellow	5.9	0.39	
	500 ml. 6N NaOH	Yellow	26.7	1.74	
	1000 ml. dist. H_2O	Pale Yellow	17.8	1.16	
	300 ml. 1:3 HCl	Pale Yellow	13.7	0.90	
			281.4	18.39	18.39
			Total Recovery		20.67

*The total chromium available was taken as 1538.8 milligrams.

The literature on the chemistry of chromium is somewhat scattered, and from all appearances the large majority of chromium compounds fall into the category of complex compounds, of which there are more than two thousand[4].

The following is a very brief discussion of some of the major concepts of chromium chemistry.

The chemistry of chromium was in a confused and disorganized state until Alfred Werner[3][4] proposed his coordination theory, which, although based on purely empirical evidence, is still after nearly fifty years the only logical explanation for the peculiar behavior of chromium compounds. With the more recent developments in atomic theory and quantum mechanics, his theory has been given a highly satisfactory explanation which amounts virtually to a positive proof of his postulates.

Werner observed that the valence theory could not explain the reactions of a number of the elements, among which was chromium. He noted that when their combining power, as judged by the valence number, was exhausted, they still had the power to participate further in reactions. The so-called affinity bonds accounted for by the valence theory he called the "primary valences" and the other bonds he called "auxiliary valences."

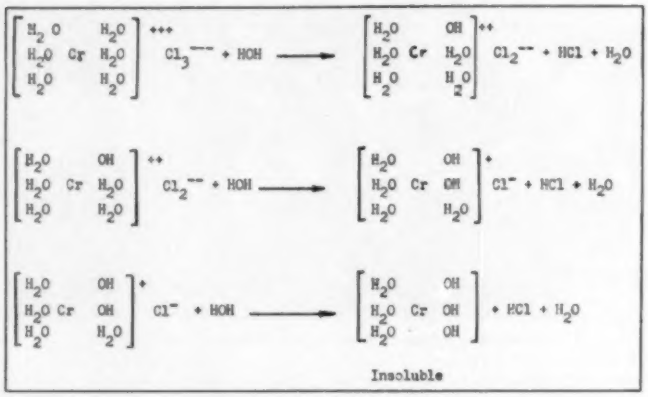


Fig. 2—Hydrolysis of Chromic Chloride

The number of these auxiliary valences which an element possessed he called the "coordination number," which in the case of chromium is six. This value is a function of the available space around the central atom.

He divided the chromium salts into seven types that are illustrated here by the simple case of chromic chloride. (Fig. 1) It is to be understood that the same rules apply to other chromium compounds, taking into account, of course, the valency of the anions under consideration.

The first three of these compounds are called the α, β and γ forms, respectively. When these compounds are treated with silver nitrate in aqueous solution, the α form loses all three chlorine atoms, while only two are precipitated from β form, and only one from the γ form. The chlorine in the other four forms is unaffected. Conductivity measurements on aqueous solutions of the first three forms show that they function as four-, three-, and two-ion solutions, respectively. The chlorine which has entered the coordination sphere, indicated by the brackets, is not ionizable.

Many different types of ions and uncharged compounds are capable of entering the coordination sphere. The ions which enter carry their charges with them and the charge of the resulting complex is the algebraic sum of the charges on the central chromium atom and those on the ions in the coordination sphere. If uncharged groups such as water or ammonia enter the coordination sphere, the net charge of the chromium remains unaffected.

The last four possible types of chromium chloride may be formed in the presence of hydrochloric acid and sodium chloride in large excess.

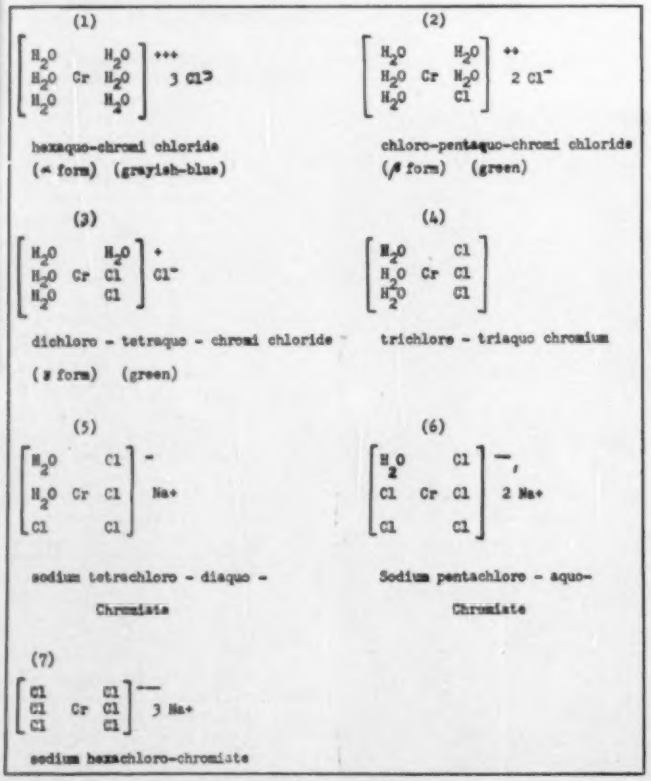


Fig. 1—The Seven Types of Chromium Salts

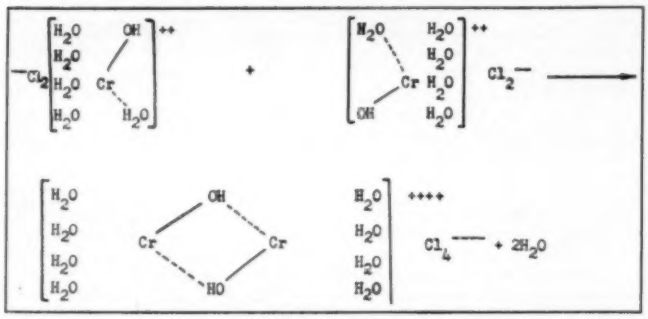


Fig. 3—Olation of Chromium

Other Chromium Complexes

Stiasny [7], Theis [8] [9] [10], and others have arranged some of the more common anions in the order of increasing ease of penetration into the coordination sphere, as compared with water: nitrate, water, chloride, sulfate, phosphate, formate, acetate, sulfite, hydroxyl, tartrate, citrate and oxalate.

Nitrate has a very low penetrating power and the chromic nitrates always contain nitrate in the ionized form. The anions at the oxalate end of the series, on the other hand, have very great penetrating power, and are always found to be complexly held. Indeed, it is almost impossible to prepare chromic oxalates which contain ionically bound oxalate. Carbonate, carbonyl, and many other groups penetrate into the nucleus very readily, but their relations in the above series have not been established.

Anions may replace other anions within the complex, following the same general order above.

The penetration power of water is very low, being about the same order as that of nitrate or chloride, although it will slowly displace complexly held ammonia.

All of the chromium chlorides whose nuclei are cations are extensively hydrolyzed in aqueous solution, and the higher the pH, the greater is this tendency. The chloride ions are displaced by the hydroxyl ions. Hydrolysis of chrome salts is always accompanied by acid formation. The progressive hydrolysis of chromic chloride has been expressed by the equations in Fig. 2. Hydrolysis may be accelerated by addition of alkali or retarded by addition of acid. Chromium salts which do not contain complexly held water (aquo groups) generally do not hydrolyze.

Olation

The next step from the above reactions is a process called "olation," shown in Fig. 3.

The olated compound contains one or more of its hydroxyl groups between two chromium groups. The hydroxyls are attached to one chromium by a primary valence and to the other by a secondary valence, thus: Cr - - - OH———Cr. The larger the number of hydroxyl groups in the nucleus, the more extended is the olation and the greater the increase in molecular size. As the molecular size of these olated complexes increases they approach a semi-colloidal degree of dispersion. Olation is favored by heat, increasing concentration, increasing basicity, and by time. The olation process may be reversed. Although the olated hydroxyl groups are relatively inert toward added acid, they are not entirely so, and if the period of contact with the acid be long enough, especially if heat be applied, de-olation will occur. Also, dilution favors de-olation. When de-olation takes place, the freed coordination bond satisfies itself with a water molecule.

The nature of the other groups in the complex greatly influences the resistance of the hydroxyl olation linkage toward acid. Groups such as oxalate, which have a very high affinity for the central chromium atoms, leave but slight secondary valence forces for maintaining the olation linkage, so as a consequence the link is easily broken. Anions that have less attraction for the chromium, such as chloride, leave greater secondary valence forces available so that the link is proportionately more resistant to acid.

Most of what is known regarding olation is based upon the work of Stiasny[7] and his collaborators.

Oxolation

Chromium compounds may also increase their molecular size by simple polymerization processes, which, also, are influenced by increasing basicity, by time and by temperature, but water molecules are not eliminated as in olation.

Continued heating of olated compounds results in formation of "oxo" compounds in which two chromium atoms are linked together by an oxygen atom: Cr - - OH —— Cr. These compounds are more stable and resistant to acid than olated compounds. Oxolation is shown in Fig. 4.

In the commercial cation exchange resins, the active groups are phenolic —OH groups, and sulfonic acid —SO_3H groups, both of which are attached to benzene rings. It is believed that there are at least two possible ways in which the chromium may permanently attach itself to the resins: 1) by means of secondary valence forces whereby the phenolic or sulfonic groups, or both, penetrate the coordination sphere, forming stable complexes, or 2) by forming olated or oxolated "bridges" between the active resin groups, which also serve to form stable complexes.

As for the anion exchange resins, no satisfactory theory for complex formation has yet been evolved. However, a new method of elution has been worked out, which has not as yet been completely tested in the laboratory. It consists essentially in reducing the chromate, which has been adsorbed by the anion resin, to the cationic trivalent chromic ion by means of

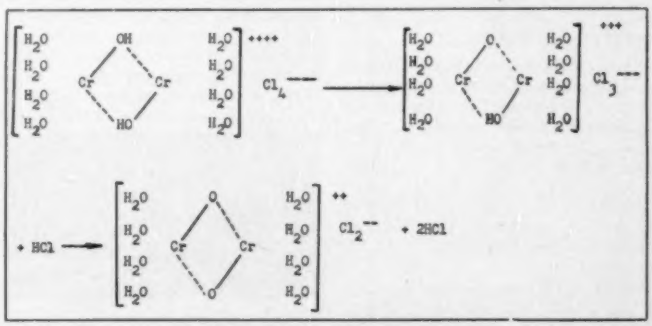


Fig. 4—Oxolation of Chromium Compounds

hydrogen peroxide as is shown in Fig. 5 in the presence of chloride ion.

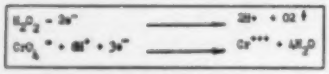


Fig. 5—Elution of Chromium from Anion Resin

Since chloride has little tendency to penetrate the coordination sphere, it is believed that no anionic complex ions will be formed, and complete elution may be effected.

The chief drawback to this method lies in the possible attack of the resin by the free oxygen gas released from the peroxide in reducing the chromate. At this time the work has not been carried far enough for results to be reported.

Summary

An attempt has been made to develop a method for removing chromium from plating wastes, both for detoxifying the wastes and recovering the chromium, by utilizing ion exchange resins. The resins are effective in removing the chromium from solution, but no satisfactory methods have been developed for regenerating the resins by direct replacement reactions. A method for removal of chromate from anion exchange resins has been proposed, but not fully tested. A detailed study of the chemistry of chromium has been undertaken.

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Lyman Cox Elected Chairman Delaware's New Water Pollution Commission

High Tribute to Industry Representative

A new Water Pollution Control Act was passed by the Delaware Legislature during its last session. The Act establishes a Water Pollution Commission which will have the responsibility of enforcing the new anti-pollution law as well as

earlier laws relating to pollution control and abatement. It will issue general rules and regulations concerning water pollution control, make investigations, conduct studies and research, and order curtailment or cessation of pollution.

Among the three industrial representatives appointed to the Delaware Water Pollution Commission the Governor named Lyman Cox, Wastes Disposal Engr. for the E. I. du Pont de Nemours & Co., Wilmington, Del. Much to Mr. Cox's surprise at the organization meeting of the Commission he found himself elected to the chairmanship of the Commission.

When an industrial waste engineer in the employ of industry is chosen to head a State Water Pollution Control Commission we contend that history has been made. On the other hand this action speaks volubly of the regard of the members of the Delaware Commission for their fellow member Lyman Cox, himself a representative of a major industry and polluter.

In reply to our question, "On which shoulder will you be carrying the most water, Lyman?" his reply was, "It is simply my nope to assist the Commission in the establishment of a firm and supportable foundation for the work which will have to be done here in Delaware. The principal tenet must be *'the reasonable use of water,'* in which the Commission will conduct educational programs, and will seek to obtain improvements in stream conditions by cooperative means until it is demonstrated that a stronger approach is required."

P. R. Taylor Exec. Officer of Water Poll. Cont. Adv. Bd.

Announcement has been made of the appointment of Perry R. Taylor as Executive Officer of the 11-man Water Pollution Control Advisory Board. Mr. Taylor succeeds Kenneth C. Lauster, who was recently appointed Chief Basin Engineer of the North Atlantic Drainage Basins area.

Mr. Taylor will act as coordinator of administrative details for the Board and keep members apprised of developments in the national water pollution control program, over which the Board sits as a reviewing body.

Mr. Taylor is an analyst for the Public Health Service, having recently transferred from the Bureau of the Budget, where he was an examiner for the U.S. Coast Guard, and the Bureaus of Engraving and Printing, the Mint, and Narcotics.

A graduate of the U. S. Naval Academy, Mr. Taylor has served as Secretary to the Mississippi Valley Commission of Public Works and to the Water Planning Commission of the National Resources Board.

Dominican Republic Constructing Nationwide Water Supply Systems

The Dominican Republic has completed the fourth year of a $30,000,000 government program to provide modern water supply systems for every city, town and village in the Republic. At this writing more than 2,250,000 feet of pipe, now delivering more than 36,000,000 gal. of purified water daily, has been installed.

According to the Dominican Republic Information Center in New York City, when the present construction program is concluded, in November, 1951, "the Dominican Republic will probably be the only tropical country in the world with pure water available on tap even in remote rural areas."

The program began late in 1945 with the laying of the Ciudad Trujillo Supply Line, thirty inches in diameter and twenty-five miles long, by the Lock Joint Pipe Co. Pipe installed since that date has ranged from two to thirty inches in diameter.

Twenty-two windmills over drilled wells have been completed out of a schedule calling for the drilling of 110 wells in isolated rural locations. Work is now underway on the fifty-third individual location, all of which are supplied with storage tanks and thirty of them are equipped with pumps.

REPORT OF F.S.W.A. BOSTON MEETING CONTINUED

Second and Final Installment

THE first installment of the report on the 22nd meeting of the Federation of Sew. Wks. Assns. at Boston Oct. 17-20, 1949, appeared in the December issue. That installment reviewed the highlights of the meeting, the new officers, actions of the Board, awards, and the papers presented on the first day of the convention.

B. W. Dickerson
Engr. Dept.
Hercules Pow. Co.
Wilmington
Del.

H. Heukelekian
Assoc.
N.J. Agr. Exp. Sta.
New Brunswick
N.J.

C. N. Sawyer
Assoc. Prof.
Mass. Inst. Tech.
Cambridge
Mass.

J. F. Laboon
Chairman
Allegheny Co.
Authority
Pittsburgh, Pa.

Industrial Waste

Geo. J. Schroepfer
Prof. San. Engr.
Univ. of Minn.
Minneapolis
Minn.

Lyman Cox
Waste Consult.
Dupont
Wilmington
Del.

Twin Cities' Tale

First presentation on Tuesday morning was a motion picture titled "A Tale of the Twin Cities." This well done picture told the story of the Minneapolis-St. Paul San. District, its sewage treatment plant and how the waters of the Mississippi River have been cleaned up by the operation of that plant.

INDUSTRIAL WASTES

The Tuesday morning session was devoted to papers dealing with industrial wastes. **Dr. F. W. Mohlman,** Director of Laboratories, Chicago San. District, presided at this session.

Formaldehyde Wastes

"HIGH-RATE TRICKLING FILTER OPERATION ON FORMALDEHYDE WASTES" by B. W. Dickerson, Engineering Dept., Hercules Powder Co., Inc., Wilmington, Del.

Mr. Dickerson reviewed the original problem which included mixed acid, oil, and aldehyde wastes. By means of bottling up, recycling, and other standard practices, the oils and acids were removed from the waste, leaving only the formaldehyde to be treated. Based on pilot plant studies, a high rate trickling filter was constructed for operation on the wastes using a 40 to 1 recirculation ratio. The effluent from the trickling filter goes to a lagoon for 13 days' storage before discharge to the stream. It is necessary to add ammonia to satisfy the metabolism needs of the bacterial slimes on the filter. The filter reduces the formaldehyde by 35 per cent and another 60 per cent is eliminated in the lagoon. To start the filter, manure and skimmed milk were used. The filter removes 355 lb. of formaldehyde per day. Ponding was caused by the presence of sodium formate, but when this waste was equalized throughout the day the problem disappeared. Some ammonium phosphate is added to supply both nitrogen and phosphorous needs.

Discussion by **H. Heukelekian,** Dept. of Sanitation, New Jersey Agr. Expt. Sta., Rutgers University, New Brunswick, N.J.

Dr. Heukelekian pointed out that the paper illustrated the need for and the reward of pilot plant research. As a result of this pilot plant study, it was possible to accomplish an almost impossible task. Low rate filters are not applicable to this waste.

Dr. Heukelekian suggested that perhaps smaller stones could have been used in the filters, and that hexamethylene tetramine might be used as a source of nitrogen because it is not toxic. The need for an equalization tank was also emphasized.

Industrial Waste Forum
(Outdrew Operators' Forum 2 to 1)

Distillery Wastes

"TREATMENT OF DISTILLERY WASTES" by A. B. Davidson, Chem. and San. Engineer, Schenley Distillers, Inc., Cincinnati, Ohio.

With 60 distilleries in Kentucky discharging wastes equivalent to a population of nearly 8,000,000 persons, the need for waste treatment is obvious. Mr. Davidson described the operation of a distillery and the development of a process to recover cattle feed and distillers' dried solubles from the wastes. As a result of these processes about 98 per cent of the B.O.D. is removed in these recovery processes. The waste can be treated on high rate trickling filters with a reduction of 93 per cent of the applied B.O.D. load. Between recovery and waste treatment, the B.O.D. is reduced by 99.9 per cent.

Discussion by **M. W. Tatlock,** Cons. Engr., Ralph L. Woolpert Co., Dayton 2, Ohio. In the absence of Mr. Tatlock his paper was presented in brief by Prof. George L. Schroepfer of the University of Minnesota.

The discussion was devoted to an outline of the problem of treating a yeast plant waste. High solids and high B.O.D. of these wastes make it

impossible to treat them directly. For this reason it has been found feasible to digest the wastes as a pretreatment before they are discharged to a high rate trickling filter.

The B.O.D. of the original waste is 3,258 ppm. Digestion reduces this load to 900 ppm. After the trickling filter and its accompanying clarifier, the effluent has a B.O.D. of 135 ppm. When diluted with condenser water this B.O.D. is reduced to 44 ppm. which can be discharged to the receiving stream without nuisance. Gas produced amounts to 0.9 cu. ft. per lb. of volatile matter.

Trickling filters of the standard variety and of the back-wash variety are used. Rotary distributors are used with a recirculation of 1:1. The problems of rising sludge were finally licked by special studies of the sludge removal mechanisms. The Tow-Bro mechanism with special modifications solved the trouble and made it possible to remove the sludge almost continuously.

Discussion by **C. N. Sawyer,** Assoc. Prof. San. Engineering, Mass. Inst. Tech., Cambridge, Mass.

Dr. Sawyer reviewed the studies which he had conducted on the problem of rising sludge and showed curves which gave the results of these studies. Three types of sludge collectors were used in the experiments. The Tow-Bro sludge collector gave acceptable results but only after modifications which included blanking off some of the ports in the arms nearest the center of the tank, and the installation of special plows between the ports to direct the sludge blanket into the suction ports.

of this type published in the May, 1949, issue of *Water & Sewage Works.)*

The original plans called for handling the waste for 102 communities, but agreement with all of them could not be reached. The Authority has revised its plans and is now proceeding with a program to handle the wastes from Pittsburgh and 59 surrounding communities. This program will cost $55,000,000, and Pittsburgh has already passed the necessary ordinance for its share of the cost. Those communities that have not entered the plan will find that treatment of their wastes will run from 25 to 100 per cent higher than it would have under the first Authority program.

English Practice

W. F. Brown
Ch. Engr.
Colne Val. Sew. Bd.
Herts
England

R. S. Rankin
Mgr.
San. Eng. Div.
Dorr Co.
New York City

Air Diffusers

N. E. Anderson
Engr.
Sew. Tr. Design
San. Dist.
Chicago, Ill.

W. E. Gerdel
Supt.
Sew. Treat.
Cleveland
Ohio

Mechanical Equipment

F. L. Flood
Cons. Engr.
Metcalf & Eddy
Boston, Mass.

C. R. Velzy
Cons. Engr.
Nussbaumer, Clarke
& Velzy
Buffalo, N.Y.

Meat Packing Wastes

"Treatment of Wastes from the Meat Packing Industry" by Leland Bradney, Walter Nelson and R. E. Bragstad. Mr. Bradney is Supt. of the Sewage Treatment Plant, Mr. Nelson is Mech. Supt., John Morrell & Co. and Mr. Bragstad is City Engineer, all of Sioux Falls, So. Dak.

Mr. Bradney presented the paper and called attention to the fact that losses are reported on a per 1000 lb. killed basis instead of on a per hog basis. Grease and nitrogen compounds cause the most trouble. At the Morrell plant losses are carefully watched and the grease loss is kept down to 4 lb. per 1000 lb. of kill. This is higher than the 0.1 lb. idea suggested by Mortensen of Swift and Co. but is less than the 5 to 12 lb. average loss reported by Mohlman.

The best index of waste strength is the organic nitrogen content. This is a better yardstick than the B.O.D. Paunch manure wastes are held to a minimum and attempts are made to hold down losses of nitrogen-containing wastes because the higher the nitrogen content, the more difficulties that occur with rising sludge in the secondary tanks.

Allegheny County Authority

"Industrial Wastes Disposal at Pittsburgh" by John F. Laboon, Chairman of the Board, Allegheny County San. Authority, Pittsburgh, Penna.

Mr. Laboon reviewed the work of the Authority in studying the industrial wastes of plants in the Authority District. These industries had a total waste load equivalent to 330,000 persons. The eventual expected load from industry has a P.E. of 910,000. The studies indicated where some losses could be prevented by recovery of byproducts. The Authority decided it would accept any waste except acid wastes (mine wastes and pickle liquor).

A formula for charging industry was developed. (This formula was included in the survey of formulas

Discussion by **Hayse H. Black,** San. Engr., Chief, Ind. Wastes Sect., Environmental Health Center, U.S. Pub. Health Service, Cincinnati, Ohio.

Mr. Black stated that the Allegheny Authority plan called for plain sedimentation for the removal of 40 per cent of the B.O.D. and chlorination of the effluent during low stream flow. While there is still much to be done, credit should be given to those industries which had made progress already. According to Mr. Black, the liberal policy of the Authority should attract industry. The consummation of this program will stand as a monument to all who will participate in it. The work of the Authority, however, has just begun.

Colne Valley Sewage Treatment

"Sewerage and Sewage Treatment in the Colne Valley Area, Herts, England" by W. Fillingham Brown, Chief Engineer, Colne Valley Sewerage Board, Richmansworth, Herts, Eng.

Because of the use of receiving streams for water supply, the sewage of the Colne Valley must receive a

high degree of treatment, both tor dry weather and storm flows. In addition, ground waters, some from infiltration from surface streams, are likely to be polluted, and, therefore, even the sludge from digestion tanks cannot be dewatered on sludge beds unless they are water tight. Vacuum filtering and flash drying of sludge is used.

Because of the locations of the sewers which generally follow the rivers, all sewage including storm flows has to be pumped. Up to six times dry weather flow is taken as storm flow. Mr. Brown described the treatment facilities, including the tanks for storm water, sedimentation, aeration, final sedimentation and digestion.

Sewer Maintenance

A. A. Appel
Asst. Supt.
Maint. Div.
Los Angeles
Calif.

W. P. Gyatt
Supt.
Bur. Sew. Tr.
Syracuse
N.Y.

Operator Training

Wm. T. Ingram
Assoc. Prof.
N.Y. Univ.
New York City
N.Y.

B. S. Bush
Dist. Engr.
Pa. H'lth Dept.
Wilkes-Barre
Penna.

Standard Methods

W. D. Hatfield
Supt.
San. District
Decatur
Ill.

Thos. R. Camp
Cons. Engr.
Boston
Mass.

Discussion by **R. S. Rankin,** Mgr., San. Engr. Div., The Dorr Co., New York City. Mr. Rankin called attention to the fact that the sewers had to be water tight and that 6 X DWF for England amounted to approximately 288 U.S. gal. per cap. per day, or about the same as 3 X DWF in this country.

The Colne Valley plant has the first comminutors installed in England, according to Mr. Rankin, who pointed out that longer detention times are designed because of the higher strength of the sewage. It should also be noted that 95 per cent treatment of sewage is accepted as desirable without question. It is also noted that the capacity of the sludge digesters is approximately 0.9 cu. ft. per cap., somewhat lower than is considered desirable in this country.

Air Diffusers

"Air Diffusers for Activated Sludge: Results of Comparative Tests and Studies" by Norval E. Anderson, Engineer of Treatment Plant Design, Sanitary Dist. of Chicago, Chicago, Ill.

Mr. Anderson reviewed the long series of tests made in Chicago on air diffusion media. Porous plates of different porosity, porous tubes, slotted tubes, saran cord tubes, etc., were compared. Maintenance of the same dissolved oxygen content at the effluent of the aeration tanks was used as a control of the comparative tests. The rate of oxygen utilization and an oxygen economy were used as a basis of efficiency comparisons.

Mr. Anderson described the various tests and presented a summary of the comparative results obtained. Air economy improves with the number of diffuser plates. Vertical plates have less economy than horizontal plates. Slotted brass pipes give poorer efficiency than do porous plates. Clogging of porous plates is dependent on the amount of air passed, not on the time they are in service. The amount of dust in the air is the controlling factor. Air at Chicago contained 2.5 mg. of dust per 100 cu. ft. The greater the concentration of dust the faster the clogging. These studies led to the adoption of a new air cleaning system using asbestos filters and electrostatic precipitation.

Plates with a permeability of 40 clog faster than do 80 permeability plates. Tubes with a permeability of 65 clog faster than do plates of 40 permeability. The "Precision Tubes" of Chicago Pump Co. have the same air economy as porous tubes but clog faster. It was observed that the first half of a battery of plates clogs faster than the second half of the battery.

Discussion by **J. J. Wirts,** Asst. to Commissioner of Utilities Engineering, Dept. of Pub. Util., Cleveland, Ohio. In the absence of Mr. Wirts, his discussion was read by **Walter E. Gerdel,** Supt. of Sewage Treatment, Westerly Sewage Works, Cleveland, Ohio. The discussion pointed out that heretofore many ideas had been presented without supporting data but that criticism could not be leveled at the work by Anderson.

Messrs. Wirts and Gerdel are of the opinion that Anderson's calculation of air economy based on dissolved oxygen in the effluent is a sound approach. According to the discussor, swing diffusers have their place in smaller installations.

Whereas Mr. Anderson had referred to clogging of the plates on the underside (from dirt in the air), Cleveland is plagued with top side clogging (air at Cleveland contains only 1 mg. of dust per 1000 cu. ft.)

In top clogging it has been found that fine sand goes into the surface to a depth of ¼ in. To overcome the difficulty, the plates are spalled by a special machine, but if the clogging is too great, spalling is not effective.

Mechanical Equipment

"Mechanical Equipment in Sewage Treatment" by Frank L. Flood, Metcalf and Eddy, Cons. Engrs., Boston, Mass.

The modern sewage treatment works consists of a great many mechanical devices from the inlet structure to the outfall. All of these devices have problems of design, installation, operation, and maintenance. Mr. Flood reviewed many of these problems for each principal type of mechanical equipment, including racks and screens; screenings grinders, both under- and above-water; shredding devices; sludge removal equipment in round and rectangular tanks; skimming devices; distributors for trickling filters, aeration equipment, chlorination equipment, sludge digester equipment, heat exchangers, vacuum filters and incinerators. (Ed. Note: Mr. Flood is preparing a series of articles in which he will treat each of these topics in more detail for *Water & Sewage Works* readers.)

Discussion by **C. R. Velzy,** Nussbaumer, Clarke, and Velzy, Cons.

To Lime or Not

J. H. L. Giles
Assoc. San. Engr.
Conn. H'lth Dept.
Hartford, Conn.

H. E. Schlenz
Vice-Pres.
Pac. Flush Tank
Chicago, Ill.

Engrs., Buffalo and New York, N.Y. Mr. Velzy pointed out that consulting engineers need to obtain information not only from manufacturers but also from operators.

Such problems as screening grinding and whether or not materials once removed should be returned to the sewage, constantly plague both the engineer and the operator. Handling grit may prove to be a particularly troublesome problem. The tendency of operators to insert shear pins that won't shear often causes considerable trouble and even injury to driving equipment.

Metering of sludge presents many difficulties and the tipping bucket meter still remains one of the best devices, particularly for small plants. Sludge pumping, too, continues to be a problem in sewage plants.

(The following session was reported by Harry A. Faber, Research Chem., The Chlorine Institute, and Editorial Associate, *Water & Sewage Works.*)

Sewer Maintenance

A movie short titled "SEWER MAINTENANCE IN LOS ANGELES" required only 15 minutes to show, but demonstrated how successfully motion pictures can be employed to educate civic groups in the details of important utility operations. This color motion picture, expertly planned, produced and directed, illustrated the high standard of operation characteristic of the Sewer Maintenance Division of that city. Alvin A. Appel, Asst. Supt. of the Division, presented the film at the Wednesday morning session and provided running comment by means of a wire recorder.

"MAINTENANCE AND OPERATION OF LARGE SEWER SYSTEMS" by T. A. Berrigan, Director, Sewerage Div., Metropolitan Dist. Commi. of the Commonwealth of Massachusetts, Boston, Mass.

The main sewer system has been previously described in the literature and Mr. Berrigan discussed only the so-called North and South systems of the Metropolitan Dist. These systems carry an average dry weather flow of 74 mgd. and serve an area of 152 sq. mi. having a population of 700,000. The capacity (maximum 125 mgd.) is inadequate for storm flows. The District Commission has a staff of 256, appointed and promoted under civil service regulations. The pumping station staff numbers 181.

All large pumping stations have been in operation for over 45 years and have reached the age at which frequent repairs are required. Since many necessary parts are no longer available from stock, patterns have been obtained and parts can be made as needed. Replacement of equipment for pumping stations was difficult during the war years and has been only slowly undertaken since that time. All possible parts are reclaimed for repair of old equipment.

Sludge Disposal vs. Utilization

W. Rudolfs
Chair.
Dept. San.
Rutgers Univ.
New Brunswick, N.J.

R. W. Rowen
Vice Pres.
Nichols Engr.
& Res. Corp.
New York City

Municipalities are forbidden by law from discharging sewage or wastes when certain standards are exceeded; for example, caustic alkalinity shall not exceed 75 ppm.; suspended solids shall not exceed 500 ppm.; fatty constituents shall not be excessive; and there shall be no explosive or inflammable substances present. The Commission has strict requirements that tests be made for hydrogen sulfide and for inflammable gases before workmen enter manholes. Even when tests indicate safe conditions, both ventilation and life belts must be employed by men engaged in this work.

Discussion by **William P. Gyatt,** Supt., Bureau of Sewage Treatment, Dept. of Public Works, Syracuse, N. Y. Mr. Gyatt pointed out that good sewer maintenance is the exception —generally because adequate funds are not available. Maintenance difficulties may be due to natural causes, to short cuts made in the original installation, etc.

He considered civil service status eminently desirable for employees of a maintenance organization, and recommended that the staff should be balanced by the inclusion of sanitary and mechanical engineers as well as civil engineers. Regulations enacted to control industrial wastes are of little effect unless constant checks are made of each industry.

Mr. Appel of Los Angeles emphasized the importance of observing safety factors. In his city all pumping stations are equipped with mechanical ventilation; workmen are permitted to enter manholes only when wearing life belts and when two workmen remain above ground; specialized waste inspectors make constant visits to industries. He considered inservice training of employees to constitute a most vital factor in a safety program.

Operator Training

"THE TRAINING OF SEWAGE PLANT OPERATORS IN THE UNITED STATES" by William T. Ingram, Engineering Field Associate of the American Public Health Assoc., and Assoc. Prof. of Public Health Engineering at New York University, New York.

Data presented by Mr. Ingram were derived from a survey made as an APHA Engineering Section project. Secretary Wisely of the FSWA cooperated in designing the questionnaire employed in the survey. Analysis of replies revealed that in 1948 at least 18 schools for the training of sewage plant operators (ranging in duration from 1 to 10 days) have been sponsored by the health departments of 20 states—generally in cooperation with other organizations. The number of plant operators attending was over 1100. Comment was obtained as to the advantages and disadvantages of combined schools (training both water and sewage plant operators) and of regional schools (training sewage plant operators within a more limited area).

What Operators Want

Uhl T. Mann
Supt.
Sew. Tr. Plnt
Syracuse, N.Y.

J. K. Adams
Supt.
Sew. Tr. Plnt
Tenafly, N.J.

The survey showed certification or licensing of sewage plant operators to be in effect, during 1948, in 15 states. These regulations were on a voluntary basis in eleven of the states, and were mandatory in four states. The costs for statewide schools ranged from nothing to $15 per capita, exclusive of living and other expenses for attendance. It was evident that state health departments are justified in allocating personnel for the operation of training schools, as benefits to sewage treatment plants are very real. There is, however, a serious need for re-evaluation of the programs offered in the schools; at present, they lack a uniformity of purpose.

Discussion by **Bernard S. Bush,** District Engineer, Penna. Dept. of Health, Wilkes-Barre, Pa. Mr. Bush called attention to the fact that the statistics on training of operators were quite impressive, but that they were very misleading. Actually, he said, the training has only "scratched the surface." One important need is for coordination of regional and statewide operator training schools. To illustrate the interest of plant operators in obtaining training, he cited the well-attended and well-planned courses conducted by the Penna. Health Dept. during 1945. The lectures and laboratory methods presented were printed in manual form. To date, 500 copies of the lectures and 700 copies of the laboratory methods have been sold.

Another important need is to sell municipal officials on the recognition and support of training schools. In-service training of plant operators is especially necessary because apprenticeship is generally impossible. Mr. Bush suggested that the Federation should undertake the preparation of a manual for the standardization of training courses.

More Ind. Wastes

Chemicals
R. W. Hess
Head
Poll. Res.
Nat. Aniline
Buffalo, N.Y.

Oil
R. F. Weston
San. Engr.
Atlantic Ref. Co.
Philadelphia
Penna.

Standard Methods

"RESEARCH PROGRAM ON STANDARD METHODS BY FEDERATION COMMITTEE AND FEDERAL GRANTS" by Dr. W. D. Hatfield, Supt. Sanitary Dist. of Decatur, Illinois.

Dr. Hatfield is Chairman, Standard Methods Committee (FSWA), and member, Joint Editorial Board for the 10th Edition of Standard Methods for the Analysis of Water and Sewage. He described plans for the enlarged edition of STANDARD METHODS in preparation and discussed the work of the Federation Standard Methods Committee which has 24 members.

One outstanding study by the Committee has been a study of accuracy and precision of methods. Nineteen of the twenty-four members carried through assignments involving a total of over 12,000 analyses. Dr. Hatfield presented a statistical study of the results of these analyses,

Industrial Wastes

S. E. Coburn
Ch. Chem.
Metcalf & Eddy
Boston
Mass.

C. C. Apar
Chief
Water Poll. Cont.
St. H'lth Dept.
Albany, N.Y.

noting indications that the precision of tests will be found to be related to the volume of sample analyzed. Only very limited data is available to prove how well the method determines what is actually present; that is, the accuracy of the test.

Discussion by **Thomas R. Camp,** Cons. Engr., Camp, Dresser and McKee, Boston, Mass., commented particularly on the evident need for the study of accuracy and precision in STANDARD METHODS. He complained that these methods have been of the "cook-book" type in the past, and pointed out that there will be more and more court cases in the future which require well-substantiated analyses. An outstanding test which is important, but is in need of improvement, is the B.O.D. test. Mr. Camp commented on differences in nutrients and in seeding materials present in the receiving stream. These differences account for the wide variation in rates of oxygen demand exhibited by different streams. A means must be found to make the standard B.O.D. method of general applicability.

Operators' Forum

F. W. Jones
Cons. Engr.
Cleveland
Ohio

E. A. Locke
Oper.
Hartford
Conn.

OPERATORS' FORUM

(The session devoted to the problems of sewage works operators was reported by J. Henry L. Giles, Hartford, Conn.)

The Annual Operators' Forum was held concurrently with a Forum on Industrial Wastes, a fact which cut considerably into the attendance at both sessions. Once again, the Operators' Forum was presided over by **Le Roy W. Van Kleeck,** Prin. San. Engr., State Dept. of Health, Hartford, Conn.

To Lime or Not

The first topic on this session paraphrased Hamlet's famous soliloquy, "to be or not to be . . . ," for the topic dealt with the liming of sludge digesters under the title of "TO LIME OR NOT TO LIME." Speaking in the affirmative was **J. Henry L. Giles,** Assoc. San Engr., State Dept. of Health, Hartford, Conn.

Mr. Giles pointed out that liming of digestion tanks is an individual problem. Small amounts of carefully applied lime have been beneficial in starting out heated digestion tanks in Connecticut. Regular liming of unheated tanks of small and moderate capacity has been found necessary. Amounts of 50 lb. per 1,000 population per week is used at state institutional digesters. Over liming and excessive spot liming has proved to be detrimental. Overloaded tanks have been kept in good operating condition with small regular additions of lime as long as no pH over 7.0 is permitted in any part of the tank.

Leading the opposition to liming of digestion tanks, **Harry Schlenz,** Vice President, Pacific Flush Tank, Chicago, Ill., gave several experiences with liming digesters for industrial wastes. His reports indicated that segregation of lime in the bottom of the tanks and subsequent

recirculation stopped all digestive action. He advocated leaving digesters alone except to feed solids judiciously, and to forget pH tests. He claims large capacity heated tanks are the answer to proper functioning of digesters.

Edwin A. Locke, Operator, Sew. Treat. Plant, Hartford, Conn., discussed operation of Hartford's four digesters to which sludge is not added during flood flows in the Connecticut River. Controlled tests showed a drop of pH from 6.8 to 6.6 when solids are added again and gas production also slowed down. Lime additions in small amounts up to 600 pounds per tank stimulated methane production.

Paper
D. E. Bloodgood
Prof. San. Engr.
Purdue Univ.
Lafayette, Ind.

Plating
J. E. Cooper
Supervisor
Water & Wastes
Ford Motor Co.
Dearborn, Mich.

Textile
Jos. A. McCarthy
Chemist
Lawrence Exp.
Station
Lawrence, Mass.

Tanning
H. T. Reuning
San. Engr.
Keystone Tanning
& Glue Co.
Ridgeway, Pa.

And Still More Industrial Wastes

Sludge Disposal vs. Utilization

Dr. Willem Rudolfs, Chairman, Dept. of Sanitation, N.J. Agr. Exp. Sta., New Brunswick, N.J., opened the discussion on "SLUDGE DISPOSAL VS. SLUDGE UTILIZATION." He advocated utilizing sludge for its humus and fertilizer value as done by the ancients. He pointed out that we can destroy sewage sludge and get rid of it cheaper, but we need the nitrogen and humus badly to replace that which we remove from the soil annually. Sludge will build up the water holding capacity of the soil much needed during the dry summer months. Also, the utilization of sludge leads to reclaiming by-products from sludge and industrial waste not otherwise considered necessary. In closing Dr. Rudolfs emphasized that we have been destroying our resources. The time is here or past when we *must* return to the soil that which we have been taking from it. Nature takes one hundred years to reclaim barren soil.

R. W. Rowen, Vice President, Nichols Engineering and Research Corp., New York City, discussed incineration of sludge, summarizing different methods of heat drying and incineration which he gave as the sanitary method of sludge disposal. He illustrated economies for combining garbage, refuse, and sludge incineration and stated that present facilities in use or under construction will incinerate 10,000 tons daily of wet sewage sludge—(such a loss to the soil!—Ed.)

Laboratory Tests

Wallace W. Sanderson, Assoc. San. Chem., Div. of Lab., State Health Dept., Albany, N.Y., discussed "LABORATORY TESTS FOR THE SMALL PLANT." For sampling, he recommended avoiding floating solids and using catch samples to test at a different hour each day. When one sample at maximum flow with time adjusted effluent sample shows good results, the rest of the day or night is sure to be satisfactory. Over a long period of time many grab samples collected in proportion to the flow and integrated will show over all plant operation. Settleable solids tests will show effectively sedimentation efficiency of a small plant. Time consuming tests are not needed. He recommended that the operator note the quantity of sludge and the physical qualities, whether digestion proceeds normally or is retarded by abnormal loads. Bacteriological control is shown by a chlorine residual of 0.5 ppm. after 15 minutes' detention, especially when tests are made following the peak flow for the day. $300.00 was given as an outside figure for needed laboratory equipment for a small sewage treatment plant with one operator.

What Operators Want

Uhl T. Mann, Supt., Sew. Treat. Plant, Syracuse, N.Y., stated that "WHAT OPERATORS WANT MOST FOR SEWAGE PLANTS" is more money for the operator and upkeep of the plant. The perfect plant is yet to be built, but he wants better sewage treatment plants. Long term planning by the public, governmental agencies, manufacturers of equipment, engineers and contractors is needed! Start now to plan for the future, it may take ten years, Mr. Mann thought, to get the right plant, at the right location and run by the right operator at a cost the community can afford.

Frank Woodbury Jones, Cons. Engr., Havens and Emerson, Cleveland, Ohio, continued the discussion by agreeing on most items with Mr. Sanderson and added that a single man cannot be a laborer, engineer, and chemist, but a good mechanic who can do repair and maintenance, keep records, make a few simple control tests and is a good operator. He urged supervision of a small plant by a large nearby plant chemist or state health department representative. He pointed out that experience has indicated that an alkalinity drop of 30 per cent through the plant processes indicates a B.O.D. drop of 85 per cent or more. He advised the single operator to make observations of the stream above and below the point of discharge of the plant effluent to indicate the efficiency of plant operation and available dilution. It was suggested that the lone operator take a composite of hourly samples one day each week and a different day each week for testing.

J. Kenneth Adams, Supt., Sew. Treat. Plant, Tenafly, N.J., said the operator is like everyone else; he wants what he cannot get. He told the operators to tell the engineers and manufacturer's representatives the troubles they have with equipment. It is then up to the engineers and manufacturers to build into a plant sturdy equipment that is easily maintained, repaired, or replaced. He asked to have anti-corrosive, adequate capacity, self-priming pumps built into plants; and also that tanks be built so that they can be completely dewatered and floors sloped to the drain.

Booster Stations

Edward A. Locke, operator, Sew. Treat. Plant, Hartford, Conn., spoke on the "DESIGN AND OPERATION OF BOOSTER SEWAGE PUMPING STATIONS." He mentioned the need for protective screens and grit chambers and pointed out that buildings should be built to give complete access to pumps. Variable speed or capacity controls should be provided and weighted check valves make hand manipulation possible to clear checks without opening them. He recommended ammeters as better in-

dicators of proper pump operation than level recorders. Proper ventilation is needed with a heater-blower to give the best results. More information is needed from pump manufacturers in order to provide better pump maintenance and to facilitate overhauling. Waterproof electrical conduits are a must for sewage pumping stations.

A. E. Casey, Supt., Dept. Pub. Wks., Stoneham, Mass., discussed design and maintenance of sewers and emphasized the need for watertight construction of sewers and manholes. Records of all work should be kept so a supervisor can figure cost of maintenance on a section of sewer and where costs can be saved by installing a manhole at a trouble point. He advised against using manhole covers with holes, as sticks and storm water get through them, and he stressed the need of using all safety precautions where men have to enter sewers. Supervisors should insist on men protecting themselves by proper ventilation, gas detectors, and rope under armpits and should "always place wood horses to route traffic and protect the men."

(In addition to the above scheduled speakers, many persons from the audience added comments pertinent to the topics under discussion. We regret that space does not permit the inclusion of their remarks in this report.—Ed.)

INDUSTRIAL WASTES FORUM

(Stuart E. Coburn*—Leader)

One of the best attended sessions of the convention proved to be the "Forum on Industrial Wastes Problems," held on the last day. Approximately 300 attended this session, productive of much interest and many questions from the floor. All in all, the chief theme of interest during the entire convention was that of industrial wastes and methods of reducing stream pollution by such wastes.

Food Products Wastes

"Wastes from Canneries, Milk and Other Food Products Plants" by Chas. C. Agar, Chief, Water Pollution Control Section, N. Y. State Dept. of Health, Albany, N. Y.

In discussing the waste problem in connection with the widespread production and processing of food products, Mr. Agar had the following to say. In the production of food products, more than in any other industry probably, conservation within the plant is the first and most economic step in reducing pollution. Many examples of improved "housekeeping" and reduction of losses and sheer waste could be cited in improving stream conditions, with the non-necessity of further steps and expense of treating the residual wastes beyond the inexpensive removal of settleable and floating solids, including greases and fats as the principal offenders. A second economical solution consists of keeping the richer food products wastes separate from the weaker wastes and converting the former into animal food products or fertilizer. If necessary to provide treatment of the residual (non-recoverable) waste biological processes have proved to be the most practical and economical solution. By conservation and improved "housekeeping" alone food products plant wastes measured as oxygen demand has been reduced as much as 90%, thus eliminating the need for any treatment of the residual waste.

Wastes from canning and food freezing plants constitute more of a problem than milk plant wastes and after maximum conservation within the plant the matter of waste treatment becomes an individual problem because of the variety of wastes. There is no universally applicable method of treatment. After removal of the gross solids by screening, settling efficiency may be improved by coagulation. If this combination be insufficient biological treatment may be necessary in addition. Lagooning, which comes under the latter heading, has become very popular. In the use of nitrates to preclude sulphide and odor nuisance from waste lagoons, Mr. Agar warned of the dangers from ammonia production and alkalinity increases in lagooned wastes which have been disastrous to fish life in the receiving stream, even where the ammonia content is only 2 ppm. and pH value only 8.2. Mr. Agar also pointed out that wastes from apple products plants had proved to be inimical to sludge digestion and to lesser degree to other biological processes.

Methods for correcting pollution from the myriad of small slaughtering establishments and meat packing plants are in general those which apply to other food products plants, especially the results attained through conservation and "good housekeeping" and salvage of animal foods or fertilizer.

Chemical Industry Wastes

The waste problems of the chemical industry were discussed by three representatives of this industry.

Bruce W. Dickerson, Chemical Engr., Hercules Powder Co., Wilmington, Del., pointed to the urgent need for more adequate methods of sampling and evaluation of industrial wastes and stream quality as well as the anticipated effects of residual wastes on stream quality. He pointed to the value of cooperation of industries and their personnel in developing the most economical and non-competitive methods of correcting stream pollution. He also discussed the possibilities of partial treatment by industry and combined treatment wherein municipal plants complete the treatment, charging industry its equitable portion of the treatment cost. In any event process changes and conservation within the waste producing plant should be the first step in all waste reduction programs.

Lyman Cox, Chemical Engr., E. I. du Pont de Nemours & Co., Wilmington, Del., who has the interesting job of also being chairman of the Delaware Water Pollution Commission (the regulatory body) while serving a large corporation in pollution matters, spoke on **"Control of New Pollution."** In this he emphasized the present need of designing waste control right into the new plant as the most important step in the future, looking toward the least costly and painful procedure in reducing pollution. Trouble causers mentioned by Mr. Cox are open steam distillation, barometric condensers, laxity in handling plant clean-up wastes, evaporator carry-over and washing of crystals or precipitates. Mr. Cox pointed out that the chemical industry has made a real start on pollution correction, not much of which had been publicized. Manual TW-1 has already been produced by an organization of the chemical industry as a guide to industry in stream pollution matters. Other manuals and methods of analysis will be produced cooperatively. Mr. Cox also emphasized the possibilities of joint treatment of industrial and municipal sewage as a practical matter of concern to the municipality as well as the industrial tax-payers.

Raymond W. Hess, Head of Pollution Research and Operational Improvements, Allied Dye & Chemical Corp., Buffalo, N.Y. (Natl. Aniline Div.), is also Chairman of the Pollution Committee of the Manufacturing Chemists Association. Mr. Hess likewise emphasized the value of cooperation between municipal sewage treatment operators and industry if the maximum good is to result at the lowest overall cost. Amongst the possibilities of practical waste treatment at the point of origin, Mr. Hess cited chlorination by industry to reduce oxygen demand values, supress the production of odors, destructive sulphids, etc., as a simple expedient of value in subsequent treatment. He

* Metcalf & Eddy Engrs., Boston, Mass.

cited cases wherein the discharge of industrial wastes to sewers have resulted in certain benefits in the treatment of the combined sewages. In other cases the increased costs of combined sewage treatment, due to industrial wastes, had beeu paid by industry at an advantage to all concerned.

Oil Refinery Wastes

"THE OIL REFINING WASTE PROBLEM" by Roy F. Weston, Sanitary Engr., the Atlantic Refining Co., Philadelphia, Pa.

Mr. Weston stated that the No. 1 problem in oil refining is that of checking the loss of free oil and reducing the emulsified oil in water leaving the plant. In answer to a question he said that the Am. Petroleum Inst. design of oil separation tanks would remove 95% of the separable oil. Before designing separators it had proved advisable to build a pilot plant and make test runs prior to final design. To break emulsions of oil coagulation had been effective in many instances and automatic back-wash sand filters have been doing effective work. Chemicals used had been alumn, ferric salts, clay and activated silica in upflow sludge blanket units. The oil laden sludge can be burned. Mr. Weston said that the cost of stream pollution abatement is in reality the cost of improved public relations and should be so considered. Like advertising costs the cost of waste abatement belongs in the overall cost of the products marketed.

Paper Mill Wastes

Walter A. Lawrence, Prof. of Chemistry, Bates College, Lewiston, Maine, who has been supervising the waste disposal by certain paper mills in New Hampshire, having reported on nitrate treatment of the Androscoggin River to suppress oxygen depletion by paper mill wastes, discussed the time delay element and other weaknesses of the standard B.O.D. test for eoaluating stream conditions and strength of paper and pulp mill wastes. In his experience the hot permanganate digestion test for oxygen consumed (chemical oxygen demand) gave the most satisfactory picture of sfream loading by paper and pulp wastes, and likewise the condition of the river below entry of the wastes. The di-chromate-acid-digestion method also gave good results but was less simple than the hot permanganate test which could be completed in less than one hour. Field tests with this method are made at several stations on the river and results telephoned in daily, permitting pump corrections in treatment or rates of release of wastes to the river.

Don E. Bloodgood, Prof. of San. Eng., Purdue Univ., Lafayette, Ind., reviewed the work under way by the pulp and paper industry, seeking methods of pollution correction. Wastes from the production of Kraft paper were the only ones actually toxic to fish. In the Terre Haute, Ind. studies on small plant scale the B.O.D. of strawboard wastes had been successfully reduced from 1000 to 87 by sedimentation or precipitation and high-rate trickling filters. Sludge disposal remained the chief problem. In reply to a question Mr. Bloodgood stated that chemical precipation alone produced a B.O.D. reduction of 45% as compared to 15% reduction by sedimentation alone.

Thos. R. Camp, Cons. Engr., Boston, stated that chemical precipitation of cooker liquors had very slight value in his experience, whereas employing trickling filters, with nutrients added to the waste, a B.O.D. reduction of 90% could be had.

Plating and Metallurgical Wastes

J. E. Cooper, Supervisor Water & Wastes Section, Ford Motor Co., Dearborn, Mich., reported that the chief problem in control of plating wastes were the plant spills. He told of the possibility of changing from cyanides to pyro-phosphates in the plating bath. He cited the utilization of spent pickling acid from steel preparations in chemical precipitation and sludge conditioning at the Dearborn Sewage Treatment Plant, the pickling liquor being transported in tank trucks. He also said that the use of a stronger acid bath in steel pickling had been contemplated. This would permit of acid recovery from the ferrous sulphate crystallized out.

Wm. S. Wise, Chief Engr., State Water Comm., Hartford, Conn., reported on the effectiveness of lagooning of cyanide plating wastes in Connecticut, wherein 20 ppm. of cyanide had been reduced to 1 ppm. in early stages but efficiency dropped gradually to about 50%. In the three lagoons in series the metals are precipitated in the final lagoon and barium sulphide is employed to reduce the cyanide. In another instance cyanides are removed by chlorination and metals precipitated with caustic soda in 3 fill and draw tanks. Pickling liquor is being precipitated with lime and the dried iron sludge is used in gas scrubbers. In pickling wastes Mr. Wise said that the rinse waters actually contained the major quantity of acid and metal (85% less as rinse waters vs. 15% as spent liquor) which was a surprise to many. In reply to a question, Mr. Wise said that Connecticut has no standards for stream pollution or wastes, every case being considered on its own and requirements set accordingly.

Textile Wastes

Joseph A. McCarthy, Chief Chemist, Lawrence Expt. Sta., Mass. Dept. of Health, Lawrence, Mass., discussing the situation in textile wastes, said that a special investigation is planned to determine the most effective means of reducing pollution by wool scouring wastes. At present Massachusetts has three full scale treatment plants for wool scouring wastes employing the following processes—

Acid Cracking
Calcium Chloride plus Carbon Dioxide
Alkaline Hypochlorite

A second plant employing the hypochlorite process for liberating wool fats, and their recovery and sale, has been approved recently. Speaking of the potential values in recovered wool grease, Mr. McCarthy noted that the leather tanning industry of Mass. buys from abroad just about the tonnage of heavy grease yearly that is lost in wood scouring in the state.

Cotton textile wastes and chemical plant wastes are practically identical. The new forms of detergents are having a serious effect on the performance of sewage and waste treatment plants, settling tank efficiency of 50% being reduced to 5% as the result to these detergents. Mr. McCarthy ended by saying that no matter what one may have learned about a particular waste as of "to-day," by "tomorrow" the manufacturer will have a new or modified process and a waste of different characteristics to cope with.

Tanning Wastes

Thos. M. Camp, Consulting Engr. Boston, discussed the nature of wastes from leather tanning and noted that calcium carbonate deposits from hide preparation wastes had choked sewers. He also noted the dangers of hydrogen sulphide production in sewers carrying tannery wastes. Biological treatment is the most effective method of treating tannery wastes, although the color is not appreciably lowered, and chemical precipitation with iron or alumina salts is of little help in color reduction. Lagooning is the effective and economical method of disposing of the great bulk of sludge removed by treatment. The sludge, amounting to 10% of the total volume of wastes, is highly alkaline and will soon clog sand drainage beds with calcium carbonate. The sludge may be dewatered by use of centrifuges or with vacuum filters if treated with filter aids and the pH is adjusted to the optimum range.

NEW BLADELESS SEWAGE AND TRASH PUMP

Its Evolution, Development and Service Record

by

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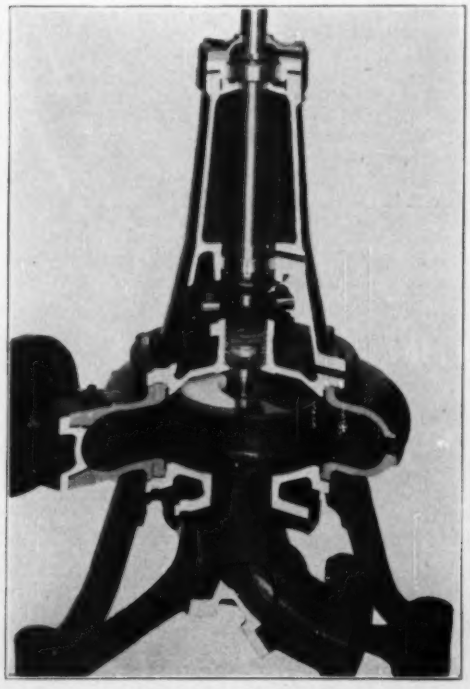
Chief Engr., Hydraulic Division
FAIRBANKS, MORSE & CO.
BELOIT, WIS.

CLEAR water pumping presents no unusual problems other than the most efficient design for a given condition. The handling of liquids containing foreign substances is, however, fraught with serious difficulties. Entrained trash such as solids, rags, and other fibrous matter can and has been a continuing source of trouble for the pump builder and user for many years. This material rendered reciprocating or plunger pumps inoperable within a few hours and conventional centrifugal clear water pumps fared but little better.

The best centrifugal pumps designed for clear water service are provided with blades or vanes accurately shaped and sharpened so that the liquid is properly guided during its passage through the pump. This is essential for the attainment of maximum efficiency. These sharpened blades were entirely unsuitable for handling water containing trash and such pumps could be used only where complete and expensive screening was employed.

The first real solution to the problem was provided by Mr. A. B. Wood, about 1915. At that time Mr. Wood was Mechanical Engineer for the Sewerage and Water Board of New Orleans, Louisiana. Due to the very unusual requirements in that City, where every drop of sewage and storm water has to be pumped, he found no pump on the market that suited his requirements. From this fact and his previous experience with pump design he conceived and had manufactured for the City a pump which could pass such trash without excessive clogging and covered his invention by a patent.

The Wood trash pump utilized a novel blade shape; the leading edge of the vane was rounded on a large radius to deflect the water streamlines away from the vanes and was effective in forcing the trash entrained in sewerage waters away from the blades and into the flow channels of the impellers. The vane was then tapered toward the trailing edge to assure a liberal passage for trash having

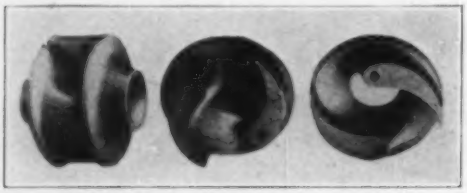


Cut-away Model of 4 in. Size New F-M Bladeless Impeller Sewage and Trash Pump (Fig. 5412-K)

At the Beloit Demonstrations

R. H. Morse, V.P. in Chg. of Operations (left), and R. C. Glazebrook, inventor of the new pump, display duster and overalls put through one of the 4 in. pumps.

passed the leading edge. These two features were also instrumental in assisting the impeller to disgorge large pieces of fibrous trash which might catch on the blading. Only two blades were used to assure maximum openings for the passage of large solids and the shape of the channel in a longitudinal plane resembled a standard elbow to permit long solids which could flow through standard piping to make the necessary turn to pass through the impeller.



Sectioned View of the Wood Trash Impeller

The efficiency of the Wood trash impeller was nearly equal to conventional clear water pump efficiencies of that era and pumps of this type were very successful in service handling sewage.

During the period from 1916 to 1925 many of these Wood trash pumps were installed in the City of New Orleans and other localities. In 1925 the right to manufacture and sell the patented Wood trash pump was acquired by Fairbanks, Morse & Co., and throughout the life of this patent agreement Fairbanks, Morse & Co., with Mr. Wood in capacity of consulting engineer, blazed the trail for modern sewage handling and treatment.

While competitive from an efficiency standpoint when developed in 1915, the Wood pump design with its bulbous vane leading edge did not compare favorably with values of clear water pump efficiency attained in the nineteen thirties. Furthermore, because of the thick blade cross-section of the Wood pump vane, these impellers could not readily be machine turned to smaller diameters for reduced capacity-head conditions without marked sacrifice in efficiency due to the broad width of the trailing edge of the blade.

These considerations combined to influence manufacturers to depart from the basic Wood blade to a thinner vane with less rounding of the leading edge. Much higher efficiencies resulted—in many cases 10-20 points better than those attained by the Wood patented design. These modified designs could also be reduced in diameter by machine work only thereby simplifying standardization and manufacture of these pumps on a volume basis with attendant reduced prices.

There is one other feature of sewage and trash pumps that must be noted in any consideration of the problem. There is general agreement among sanitary engineers and designers that any pump for raw sewage must not be less than 4" size and must be capable of passing 3" solids.

In the instance of large cities or industries this fact is of negligible importance because tremendous quantities of sewage are involved and there is no problem of limiting capacity. For the smaller communities or users however, it means that a pump must be bought which has a true rated capacity much larger than the pumping requirement. Thousands of non-clog pumps of a 4" size (which has a normal capacity of 500 to 1000 GPM for 3" solids) have been installed for sewage flows of 50-400 GPM. These units are inherently inefficient because they operate at capacities so much less than the peak efficiency condition.

This then was the state of the problem during the period of the second world war. It was obvious that a tremendous potential market existed for sewage and trash pumps due to the business impounded by the priority system and the increased demand for the sewage disposal plant. These plants were now more carefully designed by competently trained sanitary engineers who specifically wanted pumps to solve three main objectives: 1.) Sustained high performance even for relatively low sewage flow rates, 2.) Absolute freedom from clogging when handling raw sewage without screening, and 3.) Minimum size driving motors and control to minimum the cost of construction for their clients. Fairbanks, Morse & Co., recognized this challenge and determined to find a solution if one existed, for these exacting requirements.

Pumps with transparent glass or plastic heads and piping were made and placed on test in the experimental laboratory within a circulating system which permitted fibrous or stringy trash to be injected into the system under controlled conditions. Careful visual observations were made and a scheme of high speed photography devised to thoroughly study the flow of liquids containing trash. It was definitely proven that the original Wood design was less susceptible to clogging than most currently manufactured pumps regardless of manufacturer.

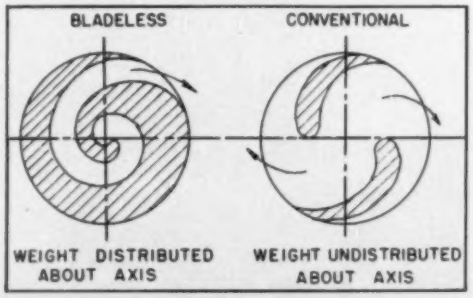
Then, impellers were produced and tested with vanes of various shapes and curvature but only one pattern proved better than the Wood design.

Circular Section Impeller

From these studies a so-called "circular section impeller" was evolved and was at least as good as the Wood design with respect to clogging, yet preserved the high efficiency of the sharper blade designs.

The basic feature of this impeller was that the leading edge of the blade, while relatively narrow at the center and therefore quite efficient, gradually increased in radius toward the shrouds, reaching an even greater radius than the Wood trash impeller adjacent to the shrouds.

Fibrous trash which readily caught on the center portion of the blade would invariably shift toward the back shroud due to the force of the flowing liquid and in that



Diagrammatic Illustration of Balance in the New Bladeless Impeller Compared With That of the Conventional Trash Impeller

position soon washed away. This impeller had the further advantage that it limited pump capacity more than any other channel shape for the simple reason that a circle contains the least area of shape for a stipulated solid diameter. Several pumps were built with circular section impellers and placed in stations for actual service trials. They gave results far superior to the units they replaced as far as clogging and maintenance were concerned and yet produced efficiencies comparable to the sharper blade designs. This permitted smaller motors than would have

been required for the original Wood trash impeller. Here then was an impeller developed in the laboratory, and field proven, which basically satisfied the objects of the experimentation.

Impeller Without Blades Conceived

During the research work, however, it was noted that pump clogging was nearly always caused by the impeller blades. Even with the best blade forms clogging could still be created by injecting continuously larger pieces of fibrous trash. The amazingly simple deduction was therefore that to *positively* prevent clogging an impeller should be designed with no blades—this was considered impossible. Further, it was apparent from the experimental testing that capacity could not be appreciably reduced or limited for a specific solid size without actually eliminating one of the two impeller channels.

These two reasonably simple deductions when struck together, as on this project investigation, produced the spark necessary to flare into a new idea and a revolutionary sewage and trash pump program was kindled. Simply stated it was this—"why not build an impeller containing a single channel without blades, the pumping effect to be obtained by so twisting and warping the channel as to produce the equivalent of one flow section of a conventional impeller."

A Balanced Impeller the Chief Problem

The chief difficulty in resolving the conception of a bladeless impeller into a practicable design was recognized to be in balancing. A single passage impeller is necessarily unsymmetrical and therefore even the casting itself cannot be in natural balance, either static or dynamic. To this natural unbalance there must be added the unbalanced hydraulic thrust caused by the jet of liquid delivered from the single passage when the impeller is in operation.

First the static unbalance was approximately corrected in the design stage by "wrapping" the water passage about the axis of rotation to obtain a maximum distribution of unbalanced weight.

Final static balance was achieved on the early experimental castings by grinding excess metal from the heaviest sections and the data on weight removed was recorded for reference. By installing this impeller in a pump it was then possible by dynamic balance testing equipment to determine the magnitude and position of weight to be added to achieve dynamic balance to offset the hydraulic radial thrust. Vibrometer records were faithfully maintained for each modification.

The impeller was then redesigned to provide cored voids within the casting to produce static and dynamic balance without excessive grinding. Further experimentation proved, however, that the amount of unbalance varied sharply with reduced impeller diameter so that a more practical solution for mass manufacture was required. The final solution to this problem was achieved by the use of variable counterweights affixed to the outside or backside of the inboard shroud.

These counterweights are carefully streamlined so that they have a negligible effect on efficiency. At the same time they serve the further useful purpose that stringy trash is effectively prevented from wrapping around the shaft on the back side of the impeller—a common service complaint on conventional trash and sewage pumps.

The New F-M Bladeless Impeller

(1) Front View; (2) View With Front Shroud Removed; (3) Back View, Showing Counter Weight Applied to Secure Absolute Balance.

Success

The inventors' predictions with reference to the clogless nature of the bladeless design were fully proven by both factory and field tests. Fibrous trash was stimulated by strips of fabric, rope, and loose waste. These materials were injected into various pumps to handle 3" solids and careful visual observations made under stroboscopic lighting.

The original A. B. Wood design, several current designs—both Fairbanks-Morse and competitive pumps, the circular section design, and the bladeless impeller were comprehensively tested in the laboratory. In general it was found that fibrous trash about 2" x 12" size would usually catch on the blading of all but the bladeless impeller. On the Wood or circular section designs this size trash would usually free itself after momentary clogging and pass through the pump. On the sharper blade designs this self-clearing action seldom took place. When trash about twice this size was employed all bladed designs would permanently clog—the bladeless impeller only continued to pass this size without difficulty. Size of trash was gradually increased until it was found that the bladeless impeller would invariably handle trash ten times the size that would clog *any* pump with blades.

It can therefore be rightfully claimed that the bladeless impeller sewage and trash pump offers the ultimate in trouble-free non-clogging service, far surpassing any pump previously offered in this country or abroad.

As a result of this amazing improvement in non-clog operation a complete line of these pumps was placed in development. Each of these pumps were more comprehensively tested than perhaps any pump on the market today. It was recognized that the nature of the suction

Two Models of Vertical Dry Well Type F-M Bladeless Pumps (Fig. 5410-K)

(The Bladeless Pump is Produced in Horizontal Models Also.)

condition materially affects the performance of non-clog pumps, particularly in the range of maximum capacities for a specific size.

From the vast experience of our engineering staff with sewage pump installations it was known that difficulty in station operation can easily be caused by the application of a pump to suction conditions different from that under which the pump was rated at the factory. In view of this the natural inclination to announce this equipment at the earliest moment was sacrificed to permit the complete testing of all sizes of these bladeless designs under all practical suction conditions.

Simultaneously with the start of the development of the complete line, several of these bladeless impellers were installed in pumps in sewage plants and relift stations where extremely severe service and heavy concentration of fibrous trash was known to exist. In all cases conventional non-clog pumps had previously been used and operating records disclosed excessive maintenance to relieve clogging.

Operators maintained careful day logs on the performance of these pumps before and after the changeover and in every instance the bladeless impeller has reduced their trouble and maintenance expense to a negligible fraction of its former value. Their reports are testimony to bladeless impeller performance. The fact that no unit has had to be dismantled is further verification of the reliability of the bladeless impeller.

Line of Pumps Developed

On large sewage and trash pumps the problem of clogging by fibrous trash is less acute than for the small sizes due to the larger solids for which the big pumps are designed. This fact, plus the low capacity characteristic of the bladeless impellers for a given solid size, obviously limit its *primary* application to the smaller pumps. In consideration of this, bladeless sewage and trash pumps are offered from 2 to 5 inch sizes inclusive. These sizes correspond to the suction and discharge flanges of the units, and each pump is designed to handle identical solids to existing sewage and trash pumps of the same size. The line, however, includes pumps for low, moderate, and high pressure service. Hence, eight separate units have been developed to provide complete coverage and produce more highly efficient pumps for the full range of capacity-head conditions normally encountered in this service.

Bladeless impeller pumps are offered for four basic modifications namely, horizontal, vertical dry pit, vertical wet pit, and vertical close coupled construction. The liquid end parts of each are identical, the only variation being in the mechanical components or the frame and bearings sub-assembly. These are designated by frame numbers and are interchangeable with similar assemblies used on conventional Fairbanks-Morse sewage and trash pumps as well as centrifugal clear water units.

It is believed that the integral frame was developed originally by Fairbanks-Morse engineers about 1915 and over the years they have been refined and standardized. It is interesting to note that they provide a line of standardized assemblies on which various types and sizes of pumps may be mounted. For example the No. 2 frame accommodates fourteen separate pumps of various sizes and designs including clear water open and closed impeller pumps, conventional sewage pumps, bladeless trash pumps, and pulp pumps. Other standard frames are similarly applicable to a variety of sizes and types.

While this frame standardization was primarily adopted to simplify manufacturing it, nevertheless, is of great value to the user in that it permits wide interchangeability with respect to spare parts. Further, it offers the maximum in flexibility for alterations to equipment to satisfy changing demands upon a station.

At the Beloit Demonstration

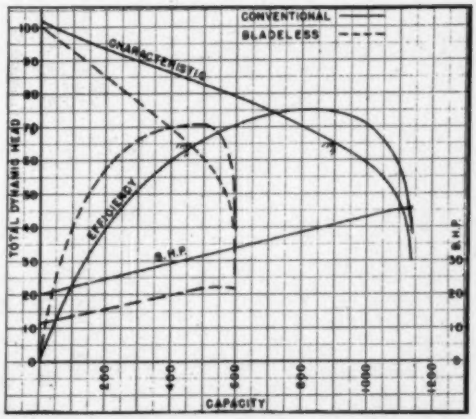
The author and staff members demonstrate the ability of a 4 in. horizontal bladeless impeller unit to handle "Roses, Rugs and Rags" with equal equanimity.

In Summary

From the foregoing it is apparent that there are five outstanding advantages of the bladeless sewage and trash pump over current conventional models.

1. When handling fibrous materials the bladeless trash pump for a specific solid size is from ten to twenty-five times as "non-clog" as conventional pumps.
2. The bladeless trash pump for a specific solid size delivers one-half the capacity of conventional sewage pumps. This fact is a distinctive asset in providing proper and efficient pumping equipment for sewage relift stations and treatment plants, where sewage flows are relatively low. The simpler station control and advantages in treatment plant operation and performance processes are noteworthy features of the bladeless trash pump.
3. By virtue of the reduced capacity and smaller change in capacity for a reasonable head variation, the bladeless trash pump permits the use of smaller driving motors. This attractive saving in initial cost of construction as well as annual operating cost represents a distinctive value.
4. Because of the program of standardization and interchangeability evolved and perfected by Fairbanks, Morse & Co., the advantages of the bladeless trash pump are fortunately not limited to purchasers of new equipment. Cities or industries using conventional Fairbanks-Morse pumps can install the corresponding sizes of bladeless trash pumps with no alterations to station piping, drive shafting, or setting.
5. It seems logical to presume that the bladeless trash pump will find enthusiastic acceptance in process handling applications other than the sewage and industrial waste pump market. In the handling of food products the popularity of the trash pump has been in large measure based upon the fact that it handles food products more reliably and with less product damage than other pumps.

This feature being even more pronounced in the bladeless pump can be of significance in sewage or industrial waste pumping, because subsequent treatment may become more effective and economical if settleable solids are disintegrated to a minimum degree. Thus the economical settling units of the plant can more effectively take the loading off of the more costly secondary treatment.



Conventional vs. Bladeless Impellers—a Comparison of Pump Efficiency and Performance

This article, by the inventor of the new F-M Bladeless Sewage and Trash Pump, is composed of excerpts from a history of F-M Trash Pumps and an account of the evolution and development of the new bladeless pump, prepared by Mr. Glazebrook for the occasion of the unveiling of this novel pump to the engineering profession.

Approximately 150 engineers and others journeyed from various parts of the country to the Beloit (Wis.) Works of Fairbanks, Morse & Co., where on Nov. 3rd and 4th they were guests of the company to inspect the Beloit Works, learn of the development of and witness demonstrations of the new bladeless sewage and trash pumps with their impressive hard-to-believe characteristics and performance.—The Editor.

Congress Reinstitutes Advance Planning Program

Congress has reinstituted the advance planning program for public works. For the next two years $100,000,000 has been authorized. The initial appropriation of $25,000,000 has been allotted by states by Jess Larson, Administrator of General Services.

Application forms and regulations under which the states and their subdivisions may apply for public works planning loans will be issued shortly. Administration of the program will be by Pere F. Seward, Commissioner, Bureau of Community Facilities.

Among the purposes of the advance planning loans are: To encourage state and other non-federal public agencies to maintain a continuing and adequate reserve shelf of fully planned public works readily available when the economic situation may make construction desirable, and to attain maximum economy and efficiency in the planning and construction of public works.

The present reserve of non-federal public works has been estimated at about 2.5 billion dollars, which is below the annual rate of $3.7 billions in 1949 and $4.0 billions estimated for 1950.

These loans, repayable to the U.S. Treasury without interest when construction starts, are available to states, cities, towns, counties, school, sanitary districts, etc.

The current appropriation will put an estimated $750,000,000 in blue printed projects on the reserve shelf. The first advance planning program expired June 30, 1947, after loans had been approved for 6,790 public works projects to cost an estimated $2,683,914,258.

Amer. Electroplaters Soc. Sponsors Research on Plating Wastes

The "Disposal of Plating Room Wastes" is the subject of a research project being sponsored by the American Electroplaters Society. The object of the project is to evaluate known methods for treatment of plating room wastes and to attempt to develop new methods of treatment.

The research work is being carried out at Yale University under the direction of Prof. B. F. Dodge. A bibliography and critical review of the literature have been published in *Plating* and copies may be purchased from A.E.S. Headquarters, P. O. Box 168, Jenkintown, Pa.

Comments of the Editors

Water Shortage—a Reflection

In New York during the war we thought we had been through about as tough a situation as we could imagine when the fuel shortage caused us to shiver, and even at one juncture to have to haul home coal by the basket full in the family car. Now, we are asked to go unshaven and unwashed one day a week because of the current water shortage. The following front page headline across the top of one of New York's more conservative newspapers tells the story.

WATER HOLIDAYS SET FOR FRIDAYS

For the No. 1 city of the country, a heck of a note we say.

The serious depletion of New York's reservoirs can only in part be charged to a lack of rainfall. According to the U.S. Geological Survey the run-off from the areas feeding New York's reservoirs during the year has been only "moderately below normal." Therefore, the principal cause of the depletion has been an increase in water use and water waste. In the latter category we would also put the great increase in water used in air-cooling installations and run to the sewers by the many large department stores, theaters and restaurants in this city.

True, if the war had not been the cause of delayed completion of the Delaware River Project the present water crisis would not have been experienced. New York would have had more water to use—more to waste. If, on the other hand, New York had adopted an effective metering program in the interim there would have been no 67% reservoir depletion, no bathless Fridays, and no need for the Delaware water for a period at least, nor the 10 m.g.d. being procured from the Jamaica Water Co. during the crisis. Likewise, if New York had regulated the use of water for air-cooling and required the installation of water conserving types of cooling equipment the situation would not have been so pronounced. A single department store, for instance, uses 24,000,000 gal. per day for air-cooling.

The water scarcity situation is also being felt in New Jersey and in a number of scattered localities over the country, both surface and ground supplies being involved. The situation in northern New Jersey is considered by Howard T. Critchlow, Chief Engr., N.J. State Div. of Water Supply, to be the worst crisis in water supply ever experienced by New Jersey, requiring wide spread water rationing if rains do not soon come. So serious is the situation that the Governor of N. J. has declared a state of emergency to exist. To reduce consumption (and waste) water pressures have already been reduced by some North Jersey municipalities. Elizabeth, N. J., has put in force an emergency ordinance, under which a person or corporation convicted of water-wasting can be fined $200, given a 6-month jail sentence, or both.

I want to use this opportunity to say something about this water supply business in general. It has become too prevalent in recent times to find situations in which privately as well as publicly owned water utilities have found themselves without sufficient water to meet the requirements of the community. Meters, or no meters, there is not enough of the product. It would seem to be a reflection on any water utility when the customer can not persuade that utility to let them have that quantity of metered water which they need for their lawns and gardens and their home comfort as long as they are ready and willing to pay the bill for it. What would one think of the local gas or electric utility if it said—"Yes, I know Mr. Customer we are in business to serve you and also to make a fair profit, but please excuse us from supplying you the current or gas which you would like to purchase from us."

This matter of not providing a water supply wholly enough for the community, and imposing restrictions on water use, is not good for anybody.

"B. O. D. vs. C. O. D."

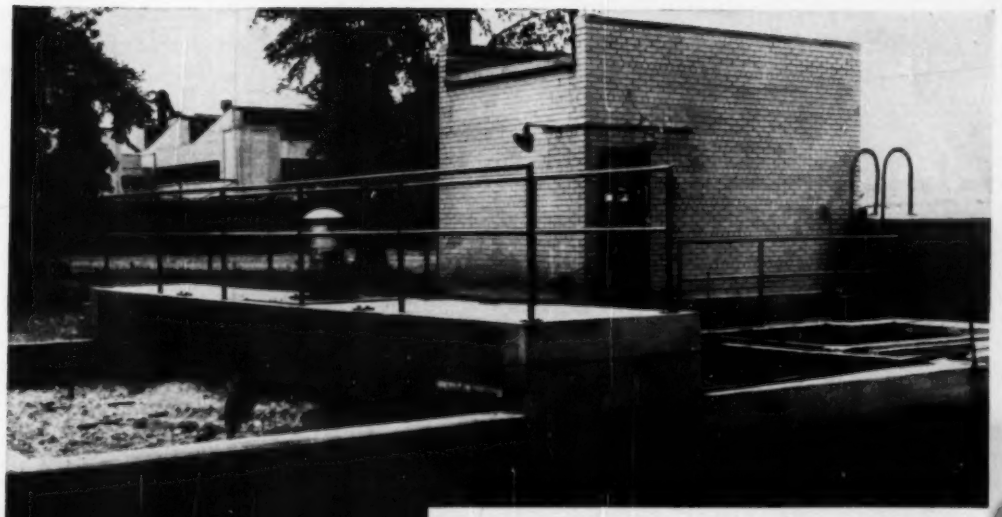
When an established laboratory test for the strength of sewages, trade wastes or effluents is shown to possess inherent weaknesses and varying degrees of unreliability, should the profession continue to spend time and effort defending such a test while attempting to correct its weaknesses—or, shouldn't it develop a more reliable substitute test as the standard test.

Some investigators intimately engaged in studying and perfecting tests for water, sewage and industrial wastes are rapidly coming to the conclusion that the so-called Standard B.O.D. Test for the determination of oxygen demanding values of wastes and polluted waters has so many inherent weaknesses, and is so lacking when it comes to yielding comparable results when applied in two or more separated laboratories, that some substitute test should be provided. Even if it appears undesirable to entirely abandon the B.O.D. Test, which requires the rather exact control of a number of variables and much involved argument in its defense, then some other measuring device or test for determining oxygen demand of sewages and industrial wastes should be chosen as a supporting or alternate Standard Test, if not the primary Standard Test.

In an article in this issue Ingols, Hildebrand and Ridenour, point out a number of weaknesses and limitations of the Standard B.O.D. Test, as contrasted to the greater reliability of the Chemical Oxygen Demand (C.O.D.) Tests now available. To our thinking, one of the more important considerations is the greater reproducability of results which can be obtained with the more exact and controllable chemical oxygen demand tests. Another is the rapidity with which results can be had with the chemical tests and the quickness with which checking on control tests can be made. A third is the greater the ease of supporting a chemical test in court, or elsewhere, as contrasted to the difficulty of defending the rather easily attacked biological test by those familiar with its frailties, and unexplainable behavior at times, such as reported by Ingols and others.

It is well to take stock of the situation wherein industrial chemists and engineers concerned with stream pollution are confronted with the manipulation of the B.O.D. Test, interpretation of its results and their application in a matter of considerable economic import to the industry they represent. This group, which can much more readily understand and accept tests based on reproducable chemical phenomena than those dependent upon biological effects, are already seriously questioning the practicability of the B.O.D. Test and are explaining the possibilities of doing something about it. It behooves us as sanitary engineers and chemists to think realistically at this juncture of progress being made in stream pollution abatement by Industry. Should we continue to support any test which will permit of endless argument between experts?

—L. H. E.



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MEETINGS SCHEDULED

JAN. 17, 1950—NEW YORK, N.Y. (Statler Hotel)
New York Section A.W.W.A. (Winter Luncheon Meeting). Sec'y, Rollo K. Blanchard, 50 West 50th St., New York 20, N.Y.

JAN. 17-19—NEW YORK, N.Y. (Commodore Hotel)
American Society of Civil Engineers. Sec'y, Wm. N. Carey, 33 West 39th St., New York, N.Y.
(Sanitary Engineering Division, Thursday, Jan. 19 A.M. and P.M.)

JAN. 20-21—NEW YORK, N.Y. (Statler Hotel)
New York State Sewage Works Association. Sec'y, R. C. Sweeney, District Engineer, State Dept. of Health, 119 E. Main St., Rochester, N.Y.

FEB. 6-8—ANN ARBOR, MICH. (Univ. of Michigan)
In-Service Training Course in Air Pollution. Director, Harry E. Miller, School of Public Health, Univ. of Michigan, Ann Arbor, Mich.

FEB. 8—PORTLAND, ME. (P.W.D. Service Bldg.)
Maine Water Utilities Association. Sec'y, Earle A. Tarr, Supt., Winthrop, Me.

MAR. 22-24—TRENTON, N.J. (Stacy-Trent Hotel)
New Jersey Sewage Works Association. Sec'y, Michael S. Kachorsky, P. O. Box 283, Manville, N. J.

MAR. 30-31—ROCHESTER, N.Y. (Sheraton Hotel)
New York Section A.W.W.A. (Spring Meeting). Sec'y, R. K. Blanchard, 50 West 50th Street, New York 18, N.Y.

MAR. 31-APR. 2—SAFFORD, ARIZONA
Arizona Sewage & Water Works Association. Sec'y, Helen Rotthaus, San. Eng. Dic., State Capitol, Phoenix, Ariz.

APR. 3-5—NIAGARA FALLS, ONTARIO. (General Brock Hotel)
Canadian Section A.W.W.A. Sec'y, Dr. A. E. Berry, Parliament Buildings, Toronto, Ont.

APR. 17-19—LITTLE ROCK, ARK. (Robinson Memorial Auditorium)
Arkansas Water & Sewage Conference. Sec'y, Prof. Harrison Hale, 118 Chemistry Bldg., Fayetteville, Ark.

APR. 20-21—SALINA, KANSAS
Kansas Sewage Works Association. Sec'y, James B. Arbuthnot, State Board of Health, University of Kansas, Lawrence, Kansas.

MAY 21-26—PHILADELPHIA, PA.
American Water Works Association (Annual convention). Executive-Secretary, Harry E. Jordan, 500 Fifth Ave., New York 18, N.Y.
(Meetings & Exhibits in the Auditorium.) Application blanks for hotel accommodations were mailed to members by the Association Headquarters Dec. 1st, 1949. All reservations will be cleared through the A.W.W.A. office.

MAY 22-24—TRAVERSE CITY, MICH. (Park Place Hotel)
Michigan Sewage Works Association. Sec'y, D. M. Pierce, State Dept. of Health, Room 334, Administration Bldg., Kansas City 4, Mich.

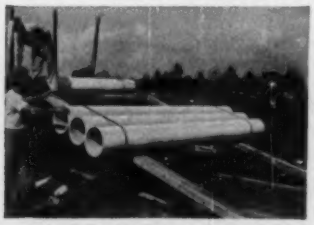
AUG. 23-25—STATE COLLEGE, PA. (Nittany Lion Inn.)
Pennsylvania Sewage & Industrial Wastes Ass. Sec'y, B. S. Bush, Penna. Department Health, Kirby Health Center, Wilkes-Barre, Pa.

Engineering Facts about
Johns-Manville TRANSITE PRESSURE PIPE
Installation Economies

SINCE the cost of installing the transmission and distribution lines may represent as much as 30 per cent of the total original investment in a water supply system, it is important that these costs be kept to a minimum. Transite* Pressure Pipe offers a combination of installation advantages which have resulted in substantial economies wherever this pipe has been used.

These installation economies start when a Transite Pipe shipment is received. Because Transite is relatively light in weight, unloading and all subsequent handling operations are simplified. More footage can be handled per truckload, trucking costs are lower, and distribution on the job site is easier and more quickly accomplished.

Mechanical handling equipment is not usually necessary except where the larger diameters of pipe are used. The sections of pipe are easily lowered into the trench, either by hand or with the aid of rope slings.



All but the larger diameters of Transite Pipe are unloaded without mechanical equipment and lowered into the trench with slings. Lightness, ease of handling and ready workability contribute to Transite Pressure Pipe's many desirable installation advantages.

In this Transite installation at Long Beach, California, the pipe was laid as fast as the trench was opened. Not more than two newly laid lengths of pipe were ever exposed at one time.

Transite's factory-made Simplex Couplings provide a number of additional installation economies.

Consisting of only three simple parts, this coupling is rapidly assembled to provide a tight, yet flexible joint. A coupling puller is the only tool required for assembly. So rapidly can the pipe be assembled in the trench that the same foreman often supervises both excavation and installation. And this speed of assembly means that trenches need be open only a minimum length of time.

Each joint, moreover, is readily checked for correct assembly as the pipe is laid. This provides advance assurance that the line will meet final test requirements and is a further help in expediting completion of the job.

The flexibility of the Transite Simplex Coupling affords another advantage. It permits deflections up to 5° at each joint, thereby allowing the pipe to be laid around wide curves and across hilly terrain without the use of special fittings.

The workability of this pipe is also a contributing factor to its economy of installation. Transite is adapted to standard water works practice and is readily connected to valves, fittings, hydrants, etc. It is tapped and drilled with standard equipment. The threads are sharp, clean and strong—connections are tight and lasting. Conventional methods are used for making large service connections.

For further details about Transite Pressure Pipe, write Johns-Manville, Box 290, New York 16, N. Y.

Assembling Simplex Couplings is a quick operation. And each joint can be easily checked for proper assembly when it is made, providing advance assurance that the line will meet final test requirements.

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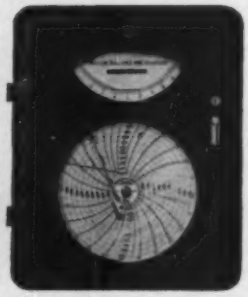
*Transite is a Johns-Manville registered Trade Mark

Simplex narrows the gap of error

With New TYPE "H" METER



An extremely accurate meter which measures flows within ± 2% over a 13 to 1 range!

We feel that a discerning engineer requires accuracy above all else in any instrument he purchases. Within its flow range the new Type "H" Meter registers measurements that are more accurate than usually encountered in commercial instrumentation and it truly "narrows the gap of error".

Type "H" Meter is specially designed for:

- Use with Venturi Tube, Flow Nozzle, or Orifice Plate.
- Measurement of hot or cold water, steam, process liquors, gases, trade wastes, sewage or sludge.
- Wall bracket, instrument panel, or floor mounting . . . outdoor or indoor as desired.
- Inclusion of three vital measuring elements—indicator, recorder, totalizer.
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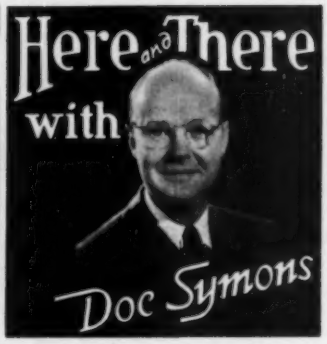

H.T.M.A.—Hoping that in 1950 everyone of my readers gets what he—or she—wants most. Just take your pick out of this list, and that's what I wish for you: Increased rates, more equipment to ease the strain on your present overloaded plants, more water, less water wastage, bigger and better sewers, less stream pollution, good public relations, more members in A.W.W.A., F.S.W.A., N.E.W.W.A., (and all the other associations), wonderful programs at technical meetings, better meals at banquets, more money for your staff, more money for your own services, less diversion of funds, more sales of your equipment or services, more and better articles for publication, funnier after-dinner speakers, more subscribers, fewer headaches (literal and figurative), more conventions with your husband, and vice versa—and—in short, I hope you have the best of everything this year, and that occasionally at least, this column of mine can bring you a light moment and a smile. For myself I'm sure 1950 holds much in store.

And now to start off the new year, let's take care of the leftover items, and the mail that's accumulated in the past few months.

* * *

Small World No. 10!—The other day a fellow sat down beside me on the commuters' train to New York. —He was Ben Harrison, Guest Manager of The Balsams at Dixville Notch, N.H., where the N.E.W.W.A. held its annual meeting in September. I had a pleasant half hour learning something of what goes on behind the scenes at a big resort hotel like The Balsams.

I also couldn't help but think that in just six weeks since I had last seen Mr. Harrison, I'd seen a dog-gone goodly number of other persons. You can get some idea of the life of a travelling columnist from—

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for example on the night of Sept. 15 I was in Dixville Notch and four days later I was at the Iowa Sew. Wks. Assn. meeting in Des Moines, Iowa. That's not so difficult, but in between, I spent one night each in Syracuse, Ithaca, and Larchmont, N.Y.

And that's been typical of this autumn (aside to "Ric" Johnson, Editor of the *J.A.W.W.A.*, please note that I said autumn and not fall). I've been "Here and There" so much this autumn that one night between trips I was having difficulty going to sleep. And my girl Gin said "What's the matter?" That was the cue I'd been waiting for for a long time and I came back with the late Paul Hansen's famous quip, uttered under similar conditions, to wit: "It must be the strange bed."

* * *

Two Readers Again. The first of two letters received in Sept. read like this: "Dear Doc—As one editor of little consequence to another in the Big Town, we know that the way to get fan mail is to let a slip show. Some of my friends that know that you and I are friends, have asked 'how come?' Do editors work only five days per week in New York? Geniuses that they are (in N.Y.) I've long suspected they could get their work done in less time than that, but you certainly let the cat out of the bag in your column in the August issue when you figured that 'it has been seven weeks—35 days, no less—since we had any rain hereabouts . . .' How come?—Harold E. Babbitt, Prof. San. Engr., Univ. of Illinois."

The same mail brought comment from S. F. (Sam II) Newkirk, Supt. and Engr., Bd. Water Comm., Elizabeth, N.J., who wrote— ". . . some old fogies, and all calendars still have seven days in a week—Perhaps you are using your 13-month calendar—or something."

No matter how often errors show up in my column, intentional or otherwise, I always receive just two letters about the slip. It's never the same two, however, and thank heavens.

Now Sam, it is not the 13-month calendar I'm plumping for, but the World Calendar which should have started out in 1950—and I'm still in favor of the Metric System.—And, oh yes, thanks for the information that there is one American city which gets its water supply from a foreign country—Calais, Maine, from Canada, you say.

* * *

And Two Readers Again. When I ran this cut in the October issue, I received two letters pointing out my error in identifying the persons

shown. One writer was R. J. (Rollie) Leveque, that fiddle playing sales manager of Omega Machine Co., who locks his wife in their room when they go conventioning on their wedding anniversaries. About the picture, "Rollie" was wrong. The correct "dope" comes from M. L. Robins, Chief. Chem. & San. Engr., Minneapolis-St. Paul Sanitary District.

Robins wrote "The picture was taken at a Central States Sew. Wks. Convention June 21, 1947, held in Duluth, Minn. The occasion was the Operators' Breakfast and the individuals are as follows from left to right: Ted Rudgal, Supt. Kenosha, Wisc.; Tom Hay, Racine, Wisc., or Frank Vilent, Kenosha, Wis. (the man with the pipe); Prof. Geo. J. Schroepfer, Univ. of Minn.; 'Tack' (P.F.T.) Langdon, Chicago; Kerwin L. Mick, Supt., Minneapolis-St. Paul San. Dist.; Maurice L. Robins (the writer), incorrectly identified as R. S. (Bob) Ingols of Georgia Tech.; George Martin (Supt. Green Bay Sew. Dist.); Glenn A. Stroessenreuther (50 per cent of the alphabet) Minn.-St. Paul San. Dist., incorrectly identified as Jos. Schwada, City Engr., Milwaukee; and Ben Storey, Minn.-St. Paul San. Dist., who was unidentified."

Now if Tom Hay or Frank Vilen will straighten us out, and if "Bob" Ingols will forgive me for spelling his name "Nichols," and if Robins and Schwada will overlook my errors, I'll again thank Walt Kunsch, Supt.-Engr., Urbana-Champaign, Ill., San. Dist. for sending the picture.—But doggone if Robins and Ingols aren't look-alikes.

* * *

My Apologies—Before I receive *Two Letters Again*, one from the Link-Belt Gilberts of Philadelphia, and one from the Combustion Engineering Nickersons of New York, I want to apologize for the mixup in pictures on page 90A of the December issue.—But then where there are pretty girls concerned, I always get mixed up.—For the record, the girl in the first column is Mrs. Bob Nickerson and the girl in the second column is Mrs. Joe Gilbert.

(*Continued on page* 83A)

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WATER & SEWAGE WORKS

Will see that you receive information desired.

(*Continued from page 82A*)

DON'T FLUSH FOR EVERYTHING—Under this intriguing title the *N.Y. Daily News* ran an editorial on the serious water shortage which is plaguing not only NewYork City, but many other parts of the country as well.

What with a growing population, ever increasing water demands of industry, wide scale attempts to make arid acres bloom, and increasing demands for air conditioning, water consumption in this country is reaching fantastic levels. To make matters worse, we are in for a long dry spell, according to H. P. Gillette, Pres. Gillette Publishing Co. and long time student of climatic cycles.

It is not that the U.S. doesn't really have enough rainfall, but the distribution is decidedly uneven and a cause for alarm in many critical areas. What to do about the matter has been uppermost in the minds of many water works men for some time and in the past few months, various newspapers and magazines have discussed the problems and solutions which include construction of long acqueducts to adequate sources, artificial recharge of dwindling ground waters, desalting of sea water, use of conservation units on air conditioning equipment to avoid waste, development of new surface reservoirs, desilting present reservoirs, stream pollution abatement, and so forth.

Most writers in the lay press have not mentioned the installation of meters as a conservation measure. It is a well known fact that many cities have effectively increased plant adequacy and staved off water shortage by the simple means of 100 per cent metering, thereby cutting down a huge amount of water wastage as well as increasing income. What holds back other cities from following that same course?—Can it be politics?

* * *

Recalling that in the past, I have been taken to task by many of my readers when I used this column for editorializing, I beg your indulgence for the preceding item.—But maybe a fellow should have one serious thought to start out a new year.—And now before I use up any more space in this issue, I'll hold over some more until next month and just say—

V.T.Y.—Doc.

May we assist you, sir?

If you're on a merry-go-round about handling air or gas, *R-C dual-ability* can help you.

That's been our exclusive job for almost a century. We've developed the most extensive line of blowers, exhausters and gas pumps in the industry, with capacities from 5 cfm to 100,000 cfm.

We're the only builders offering that *dual choice* of both Centrifugal and Rotary Positive equipment. Thus, without bias, we can suggest units that meet most closely the requirements of the work to be done.

For new installations or replacements, look to us for your needs. Alert engineering teams up with modern construction to insure long-time, satisfactory performance of R-C equipment.

ROOTS-CONNERSVILLE BLOWER CORPORATION
501 Mount Avenue, Connersville, Indiana

One of three Type H, 3-stage Centrifugal Blowers in large sewage disposal plant. Capacity 15,000 cfm, driven by 700 hp electric motor.

Type HD Rotary Positive Blower in sewage disposal work. Variable capacity from 491 cfm to 1,000 cfm. Motor driven.

ROOTS-CONNERSVILLE
BLOWER BUILDERS Since 1854
ONE OF THE DRESSER INDUSTRIES

[Overflow from the main section]

Miles Sherrill Associated With Maurice Miller, Cons. Engrs. of Louisville, Ky.

Miles O. Sherrill, Civil-Sanitary Engineer, with 25 years experience, has accepted the position of Principal Engineer with Maurice L. Miller, Cons. Engineers, Louisville, Kentucky. Mr. Sherrill was formerly associated with Michael Baker, Jr., Inc., Cons. Engineers, where he was in charge of the design and construction of all sewage collection and disposal work and the utilization and disposal of industrial wastes.

Mr. Sherrill is a member of the Society of American Military Engineers, the Kentucky-Tennessee Industrial Wastes and Sewage Works Assoc., the American Water Works Assoc., and the Engrs. and Architects Club of Louisville.

Indiana Sewage Works Assn. Meeting

The annual meeting of the Indiana Sewage Works Assn. was held on Dec. 9, at Hurty Hall, Indiana State Board of Health Bldg. in Indianapolis.

Among the topics discussed were "Sewer Service Charges in Indiana," by B. A. Poole, Chief Engr., Ind. State Bd. of Health; "Septic Tank Research Findings," by S. R. Weibel, Pub. Health Engr., U.S. Public Health Service, and "Opportunities for Advancement in the Field of Sewage Treatment," by Don E. Bloodgood, Prof. of San. Engr., Purdue University.

R. R. Baxter Now With Schleyer Pump

R. R. Baxter, former superintendent of sewage treatment at Anderson, Ind., and now recently superintendent of sewage treatment at Kokomo, Ind., has joined the staff of the E. C. Schleyer Pump Co. at Anderson, Ind. Mr. Baxter is working on special industrial waste problems.

Ohio River Compact First Annual Report

The first annual report of the Ohio River Valley Water Sanitation Commission was issued on Dec. 1.

When the interstate compact was signed on June 30, 1948, the Commission was given mandate, says the report, to regain the treasure of clean waters for the millions of people and thousands of industries in the valley of the Ohio River. Little precedent existed to guide the staffing and planning of this pollution-abatement program which is greater in magnitude than any ever before attempted in this nation. According to J. L. Quinn, Terre Haute, Ind., Chairman of the Commission, "Recruiting a proper staff was considered of paramount importance. The work of the Commission is not only concerned with highly specialized engineering evaluations but calls for men who can also inspire the cooperation and enjoy the confidence of industrial management as well as local, state and federal officials." At the present time the staff is headed by E. J. Cleary, Exec. Dir., and includes K. S. Watson, Robt. Horton, and J. R. Kinney.

TENNESSEE CORPORATION
Ferri-Floc
FERRIC SULPHATE
Atlanta, Georgia
Results Count!
• MORE ECONOMICAL
• EASIER TO HANDLE
• SUPERIOR RESULTS
The use of Ferri-Floc in water supplies has several advantages over other coagulants now in use. Economy of operation is a great factor in the minds of prospective users, but, once used Ferri-Floc immediately shows its ability to produce a higher quality of water at a lower cost.
ADVANTAGES OF FERRI-FLOC
Coagulation is effective over a much wider pH range than with alum. Color flocs may be formed in the very acid range, where alum may not be employed. On the other hand, true hydrated ferric oxide flocs may be formed at pH 9-10, or even higher for the removal of turbidity and manganese.
2. The time required for floc formation, conditioning, and settling is in many cases considerably shorter than that required for other coagulants.
3. Filter runs have been markedly increased in several cases.
4. Manganese is successfully removed at pH values above 9.
5. Effluents may be produced which are exceedingly low in both iron and aluminum.
6. Hydrogen sulfide is removed, and taste and odor improved.
7. Ferric floc does not seem to stick to sand grains to form mud balls, and is subject to less "breaking through" on the filters.
FREE BOOKLET — Send card or letter for free booklet on the advantages of Ferri-Floc to Tennessee Corporation, Grant Building, Atlanta, Georgia or Lockland, Ohio.
TENNESSEE CORPORATION

Water Problems of the Process Industries

N.Y. Sect. A.I.Ch.E. Held Symposium Nov. 17

On Nov. 17, 1949, the N.Y. Section of the Amer. Inst. of Chem. Engrs. held a symposium on "Water Problems of the Process Industries." Among the topics discussed were "Water Treatment Progress," by M. E. Gilwood, Permutit Co.; "Ion Enchangers," by V. J. Calise, Graver Water Conditioning Co.; "Sea Water for Cooling," by W. Z. Friend, International Nickle Co.; "Water-Cooling Towers," by H. E. Degler, The Marley Co.; "Air-Cooled Heat Transfer Equipment," by K. D. Demarest, Fluor Corp., Ltd.; "Water Supply Economics," by D. B. Hertz, Celanese Corp.; and "Compression Distillation," by A. Latham, Jr., Arthur D. Little, Inc.

Water Works Service Co. Moves to Philadelphia

Water Works Service Co. is moving its offices from 50 Broad St., New York, to 121 South Broad Street, Philadelphia, Penna. (Note the street name is the same but the city is different.) Water Works Service Co. furnishes services of an executive, engineering, accounting, purchasing, and administrative nature to a group of 129 operating utilities subsidiary to the American Water Works Co., Inc., and the Northeastern Water Co., including a number of municipal authorities.

These operating plants are located in 29 states from Maine to Alabama in the south and to Iowa and Kansas in the west. A large number of the companies are located in Pennsylvania and New Jersey. The personnel of the new Philadelphia office will number about 125, many of whom will be moved from New York City.

"Mayor—About those repair parts you promised to order for the big valve on the reservoir line."

WARREN
Solves Your
PIPE
PROBLEMS
BELL & SPIGOT PIPE •
FLANGE PIPE •
MECHANICAL JOINT PIPE •
FLEXIBLE JOINT PIPE •
SPECIAL CASTINGS •
SHORT BODY BELL & SPIGOT SPECIALS •
Warren Cast Iron Pipe and Fittings can be supplied in all sizes 2" to 84" with all types of joints and in accordance with Standard Specifications. Specify "Warren Pipe" for your next job.
Take advantage of our large stock of non-standard patterns, when in need of special castings to meet your individual requirements.
Warren
FOUNDRY & PIPE CORP.
55 LIBERTY ST. — N. Y. C.
WARREN PIPE CO. of MASS. INC.
75 FEDERAL ST., Boston, Mass.

Phipps & Bird
LABORATORY MIXER

IS the important piece of equipment in the Modern Water Works Laboratory. Now being used by leaders in water works research. Many superintendents and chemists have been able to reduce their chemical costs by the control of chemical dosages with this mixer. Write for literature.

PHIPPS & BIRD, INC. Richmond, Va.

DARLEY MAGNETIC DIPPING NEEDLE
$17.50

with 3 section telescoping handle
$22.25

Write Today for 68-Page Catalog

W. S. DARLEY & CO., Chicago 12

MANUFACTURERS' and EQUIPMENT NEWS

101 Cation Exchange Resin

American Cyanamid Co., Ion Exchange Div., 30 Rockefeller Plaza, New York 20, N.Y., has announced the production of a new synthetic cation-exchange resin, designated as IONAC Resin C-212. This new product is a monofunctional, nonphenolic resin, with medium high exchange capacity and improved physical and operating characteristics.

For further information on this new ion exchange resin, use a Reader Service Card on which is entered the above key number and your name and address.

"Jack" Van Atta Dies

J. R. Van Atta, Exec. Vice Pres. and Gen. Mgr., Ralph B. Carter Co., Hackensack, N.J., died Dec. 7, following a cerebral hemorrhage. "Jack" who was also called "Jake" by some of

his intimates had been associated with the Carter firm for the past fifteen years or so. He joined the firm as a sales representative in the eastern part of the country.

"Jack" Van Atta was active in the Water and Sewage Works Manufacturers Assn. and represented that organization on the Board of Directors of the Federation of Sewage Works Assns., having been elected to the post in 1948. He was a member of the A.W.W.A., the N.J. Sewage Works Assn., the N.Y. State Sew. Wks. Assn., the Md.-Del. Water and Sewage Assn. and other regional organizations. "Jack" was one of the behind the scene workers who put on the "Silver Anniversary" meeting of the N.J. Sewage Works Assn. in 1940. A native of Phillipsburg, N.J., Van Atta was 48 at the time of his death.

R. J. Driggs Represents Dresser on West Coast

Announcement has been made of the appointment of R. J. (Jack) Driggs as West Coast Representative of the Dresser Manufacturing Div. of Dresser Industries, Inc.

Before joining Dresser, Mr. Driggs conducted his own contracting business for several years. Prior to his contracting work, Mr. Driggs had been with the Armco Drainage and Metal Products. Inc. for ten years.

C. P. Gabosch Sales Mgr. M & H Valve

Chas. S. Martin, President, M & H Valve and Fitting Co., Anniston, Ala., has announced the appointment of Chester P. Gabosch as Sales Manager of the Company.

PIPE CLEANING TOOLS
FOR WATER LINES
FOR SEWER LINES

Efficient Chain Head Cleaning Auger. A Power-Driven Tool.
"Flexible" Carry-All Trailer, packs everything needed — Rod Reel, Steel Rods, Power Drive, etc.
Above: Flexible" Power Driven Pipe Cleaning Machine. Fast. Powerful. Safe.
DODGE CITY STREET DEPARTMENT
Application of Power Cleaning Machine and Chain Head Auger in 4" Line.
a few minutes for Dodge City to get at the root of the trouble with "Flexibles."

"FLEXIBLE"

UNDERGROUND PIPE CLEANING CO. — SEWER-ROD EQUIPMENT CO.
9059 VENICE BOULEVARD, LOS ANGELES 34, CALIFORNIA

161 W. Jackson Blvd. Chicago, Ill. — 401 Broadway New York 13 — 147 Hillside Ter. Irving, N. J. — P. O. Box 165 Atlanta — P. O. Box 465 Memphis, Tenn. — 801 E. Excelsair Blvd. Hopkins, Minn. — 29 Cordon Ave. Roslindale 31, Mass.
Box 167 Los Nietos, Calif. — 41 Greenway St. Hamden, Conn. — 3786 Durango Ave. Los Angeles 34, Calif. — 709 House Bldg. Pittsburgh 8, Pa. — 4435 S. E. 24th Ave. Portland 2, Ore. — P. O. Box 447 Lancaster, Texas

Roberts Filter Quarter Century Club Holds Second Annual Banquet

The Quarter Century Club of the Roberts Filter Mfg. Co. of Darby, Pa., held their second annual banquet and meeting on November 16, 1949, for employees of the company who have served the company twenty-five or more years. Two new members were admitted to the Club, making a total of eighteen service members.

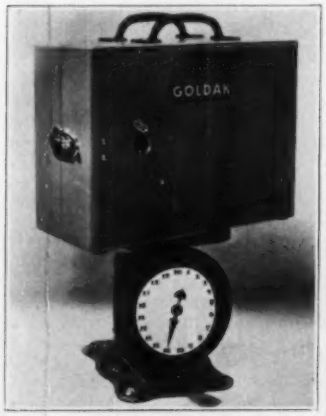
Mrs. J. W. Roberts, Sr., and Mr. Jesse W. Roberts, Jr., Secretary and Asst. Secretary respectively of the Company were made honorary members, bringing the honorary membership for officers of the Company to a total of four.

Fred R. Haddock, Chief Engineer, was elected president of the club and Percy Foster, Jr., was re-elected secretary for the coming year.

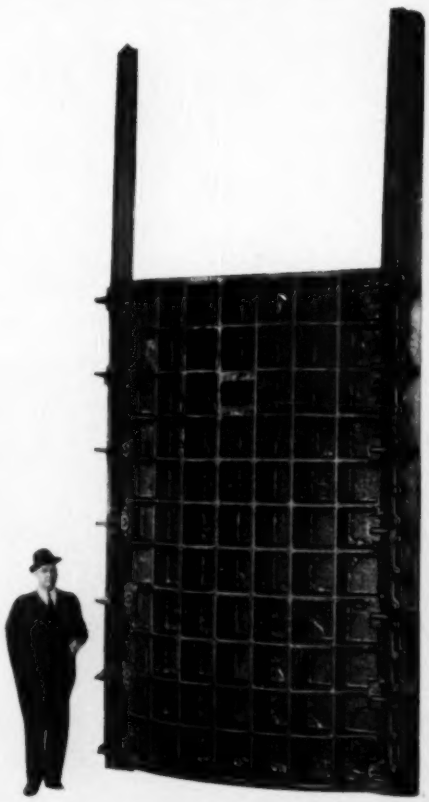
102

Pipe and Leak Locator

The Goldak Co., Glendale, Calif., has developed a featherweight electronic pipe and leak detector. Known as Model 87, the locator weighs only 11 pounds complete. It contains a new type electronic circuit which provides a strong positive location signal and gives depth as well as location of lines. The unit is shown in the accompanying photograph.



To obtain further information on this featherweight pipe and leak detector, use a Reader Service Card on which is entered the above key number and your name and address.



FILER & STOWELL SLUICE GATES

are built to stand long trouble free service. Amply proportioned for all stresses of shipment, erection and operation. They may be obtained with manual, hydraulic cylinder or motor operating controls.

THE FILER & STOWELL COMPANY
MILWAUKEE 7, WISC.

BOND-O

A safe self-caulking, self-sealing compound for jointing water mains. Used with complete confidence. Machine-blended for absolute uniformity. All BOND-O contains a germicide to inhibit oxidation by sulfur bacteria.

Northrop

Northrop & Company, Inc.
SPRING VALLEY, N. Y.

Every Bond-o Joint is a Good Joint

ANTHRAFILT
Trade Mark Reg. U. S. Patent Office
A Filter Medium For All Purposes

ANTHRACITE EQUIPMENT CORP.
Anthracite Institute Building
Wilkes-Barre, Pa.

All correspondence regarding sales and engineering should be addressed to:

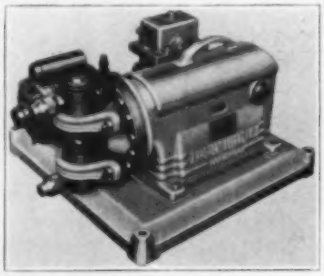
PALMER FILTER EQUIPMENT CO.
822 E. 8th St. Erie, Pa.
Engineers and Sales Agents

103

Ferric Chloride Feeder

%Proportioneers, Inc.%, Providence, R.I., has announced a new and improved chemical proportioning pump to handle 35 to 40 per cent ferric chloride solutions for sludge conditioning.

All parts of the new unit coming in contact with the corrosive fluid are specially selected for resistance to corrosion. The diaphragm is of soft rubber reinforced with whipcord, the reagent head and check valves are of hard rubber, and the metal parts are of durable Hasteloy "D" metal.



In addition to feeding ferric chloride the Ferro-Feeder may also be used for other corrosive liquids such as acids, acid pickle liquors, etc. The capacity may be adjusted over a wide range up to a gal. per min. by a variable speed drive. It is a positive displacement pump delivering an accurately measured volume at 20 psi. and it is available in both Simplex and Duplex models.

For further information on this new chemical feeder, use a Reader Service Card on which is entered the above key number and your name and address.

FORD

MONITOR COVERS

FIT 24", 30", AND 36"

METER PIT BARRELS

WRITE FOR CATALOG

Ford Catalog No. 50 contains full information. Send for your copy today. FREE.

For covering large meter pits the Monitor Cover is most useful. With lid opening large enough to permit meter reader to enter setting, this cover is used over pits containing 1½" or 2" meters, or multiple settings of smaller meters. An inner lid is available if extra frost protection is desired.

The cover is equipped with the Ford Lifter Worm Lock that opens lid easily, even when frozen.

FOR BETTER WATER SERVICES

FORD

Manufactured by THE FORD METER BOX COMPANY, INC.

Wabash, Indiana

104

Rotary Distributor Spreader Jet

Pacific Flush Tank Co., Chicago, Ill., has introduced a new type of spreader jet for application to the dosing arms of rotary distributors for trickling filters.

Made of corrosion resistant material, these nozzles feature a readily removable section consisting of the

circular orifice and the deflector. The orifice can be removed instantly, even when the distributor is in operation, if necessary. It is only necessary to press the handles of the retaining ring and the removable section slips off. Only the pressure of the thumb and forefinger is necessary to accomplish the removal.

The spreader jet is designed with wide clearances and a smooth interior wall to eliminate clogging, and the radius and contour of the deflector is designed to assure fanning out of the liquid to obtain maximum coverage of the filter media.

New Organization to Promote Ranney Water System

Announcement has been made of the formation of two new organizations to promote the development and installation of the Ranney Water

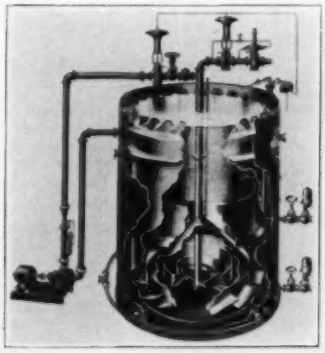
Collection System. Horizontal Underground Drilling, Inc. and Ground Water, Inc. have concluded a contract with Leo Ranney, inventor, whereby they have obtained control of the Ranney horizontal drilling process.

Maurice H. Van Bergh was elected president of both companies. The function of Ground Water, Inc. is to build and install water collector units for municipalities and industrial organizations which require a large volume of water.

105

New Water Softener

Worthington Pump and Machinery Corp. has announced a new cold process slurry type precipitating water softener and coagulator employing hydraulic energy for mixing the applied chemicals with previously



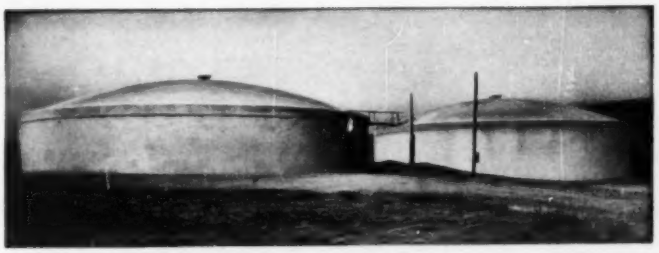
former precipitate. Optimum flocculation is achieved without the use of submerged mechanical moving parts within the softener. Complimentary recirculation of treated water maintains a uniform depth of slurry bed independent of load demand.

To obtain further information on this new unit, use a Reader Service Card on which is entered the above key number and your name and address.

J. H. Pearcy Joins Neptune in Indiana

Neptune Meter Co. has announced the appointment of James H. Pearcy to its sales staff. Mr. Pearcy will represent the company in the state of Indiana replacing John J. Carroll, recently appointed District Manager in Louisville, Ky.

Mr. Pearcy comes to Neptune with 19 years' experience in the Indianapolis Water Co.



PRE-STRESSED "GUNITE" TANKS

Above are shown two 80' diameter 750,000 gallon pre-stressed "GUNITE" water storage tanks with "GUNITE" dome roofs. We built these tanks in 1943 for the Borough of Schuylkill Haven, Penna.

Pre-stressed "GUNITE" produces a water storage tank which is bottle tight and maintenance free. They may be built either at ground level, completely underground with earth covering over the dome roof, or may be in the form of stand-pipes or elevated tanks.

Our experience in this field includes scores of tanks and silos of many types ranging up to two and one-half million gallons capacity.

The use of "GUNITE" for repair and construction of reservoirs, bridges, buildings, etc., is illustrated and described in Bulletin C2400. We will gladly send a copy at your request. On your letterhead, please.

CEMENT GUN COMPANY
"GUNITE" CONTRACTORS
GENERAL OFFICES—ALLENTOWN, PENNA. U.S.A.
MANUFACTURERS OF THE CEMENT GUN

ROTO-TROL

940

Write for Bulletin

THE 940 Roto-Trol will control your pumps, valves, alarm circuits, etc., all from one float. Each circuit is completely independent from all others, and may have several starting and stopping positions on both a rising and falling level. Can be set on the job. No special tools or experience required. All circuits, from two to ten or more, are made through snap action of mercury switches.

Write for Engineering Data.

WATER LEVEL CONTROLS DIVISION OF
HEALY-RUFF COMPANY
783 Hampden Ave., St. Paul 4, Minn.

"Our best ads are installed . . ."

Continuous stave redwood pipe and fittings

COOLING TOWERS
WOOD TANKS
STAINLESS TANKS
WOOD PIPE
MULTI-FIN UNITS

since 1903

SANTA FE
TANK & TOWER CO.
ENGINEERS • FABRICATORS • ERECTORS
5401 S. Boyle Ave., Los Angeles 11
Branches: New York, Boston, Chicago, Tulsa, Houston, San Francisco

DeLaval News

DeLaval Steam Turbine Co., Trenton, N.J. has announced several changes in the sales organization. A new district office has been opened in Tulsa, Okla., where Harold Meyer is manager.

The Lefler Wymont Supply Co., Casper, Wyo., has been appointed to represent the company in Wyoming and Montana and the Roger Brown Co., El Paso, Tex. now represents the company in southern New Mexico and the southwestern corner of Texas.

In Canada, the Superheater Co. Ltd., will represent the DeLaval Co. in the Provinces of Newfoundland, New Brunswick, Nova Scotia, Prince Edward and Quebec.

Pittsburgh Pipe Cleaner Has Subsidiary in Calif.

The Pittsburgh Pipe Cleaner Co. has announced the organization of a subsidiary company, The Pittsburgh Pipe Cleaner of California, with offices at 119 New Montgomery St., San Francisco 5, Calif. Manager of the subsidiary company is Fred. C. Morris.

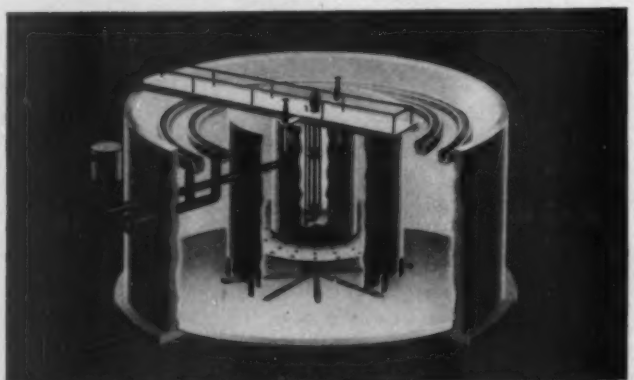
FOR WATER SOFTENING . . . TURBIDITY AND COLOR REMOVAL
. . . INDUSTRIAL WASTE TREATMENT . . .

The Clariflow

with independently-operated mixing, flocculation, stilling and sedimentation zones

A notable improvement over conventional short-retention water treatment units. Provides individual functioning of mixing, flocculation, stilling and sedimentation zones. • Its control over short-circuiting, control over each function and control of sedimentation through low weir rates mean improved effluent . . . higher filtration rates . . . longer filter runs . . . better industrial waste recovery and treatment.

Write for Bulletin 656



WALKER PROCESS EQUIPMENT INC.
FACTORY • ENGINEERING OFFICES • LABORATORIES
518 HANKES AVENUE, AURORA, ILLINOIS
PROQUIP

LITERATURE AND CATALOGS

106
REPAIR CLAMPS AND SERVICE FITTINGS

M. B. Skinner Co., South Bend, Indiana, has issued a beautifully bound catalog on **Repair Clamps & Service Fittings for Steel and Cast Iron Pipe.** This bulletin with its plastic ring and hard back cover contains 40 pages devoted to the presentation of pipe repair clamps, service fittings, gaskets, special fabricated clamps, and pictures of the M. B. Skinner Co. plant. The catalog is developed for presentation to the water industry, as well as gas and oil industry. More than fifty items are presented in this bulletin. Also included is a table showing what leaks cost.

Of particular interest to the water works man are pipe repair clamps including the bell joint clamp, the split coupling clamp, the emergency pipe clamp, pipe joint clamp and collar leak clamps. Also shown are welding patches, service saddles and street tees as well as saddle tees.

The bulletin closes with a picture of the factory and its operation and a statement that 99 per cent of all orders are shipped the same day the order is received.

This is a bulletin which every water works superintendent should have. To obtain a copy, use a Reader Service Card on which is entered the above key number and your name and address.

107
COMMINUTOR

The Worthington Pump & Machinery Corp., Harrison, N.J., has issued a bulletin on the **Worthington Comminutor.** This bulletin gives a general description of the new unit and the ten principal advantages of the Worthington Comminutor, how it functions and its construction details. There is also a section devoted to selection and application, which includes such information as characteristic curves, submerged discharge, free discharge, the setting, the comminutor, overflow baffles, use

HELLIGE
TURBIDIMETER
A TURBIDIMETER WITHOUT STANDARDS
Accurate • Foolproof • Universal

Gas MEASUREMENT OF TURBIDITY (SiO2) DETERMINATION OF SULFATE (SO4) AND OTHER APPLICATIONS

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HELLIGE
INCORPORATED
3718 NORTHERN BLVD. LONG ISLAND CITY 1, N.Y.

of weirs, and dimensions. One page is devoted to suggested channel design.

To obtain a copy of this bulletin on the Worthington Comminutor, use a Reader Service Card on which is entered the above key number and your name and address.

108

ELECTRICAL MOTOR

The Allis-Chalmers Mfg. Co., 1192 S. 70th St., Milwaukee, Wis., has issued a new 8-page bulletin on "The Inside Story of **Allis-Chalmers' 'Safety-Circle' Motor Protection.**" This bulletin describes the design and construction features of the "Safety-Circle" motor including the cast iron frame, the double insulated stator, a die-cast rotor, efficient ventilation, drip-proof end brackets, pre-lubricated bearings, precision machined feet, and roomy conduit box. The advantages of the "Safety-Circle" are presented along with the description of sizes and types.

A copy of this bulletin on the "Safety Circle" Motor Protection may be obtained by using a Reader Service Card on which is entered the above key number and your name and address.

109

ZEOLITE SOFTENERS

Lakeside Engineering Corp., Chicago, Ill., has issued a new bulletin on **Zeolite Water Softeners.** This 32-page book contains information on bed grids, brine distribution systems, softener controls, de-ionization, soap tests, comparison of zeolites, iron removal, lime-soda process, data on the design, operation, and specification of softeners and other information of interest to engineers and operators of softening plants.

To obtain a copy of this bulletin, use a Reader Service Card on which is entered the above key number and your name and address.

110

GREASE INTERCEPTORS

Josam Manufacturing Co., Josam Bldg., Cleveland 13, Ohio, has issued a bulletin on Grease Interception. Published under the title

LEADITE
The Pioneer Self Caulking Material for C. I. Pipe
Thousands of miles are—

Jointed with LEADITE for Satisfaction and Long Life
because Leadite makes a good, tight joint that improves with age. . . . and in addition, saves on installation costs.
Write for Literature.
THE LEADITE COMPANY
Girard Trust Co. Bldg., Philadelphia 2, Pa.
No Caulking

Orphans are Nice People

But "orphan" filtration equipment is a costly, aggravating nuisance. An obsolete valve, a control valve handle, or special operating table design are headaches to replace or duplicate when the "lore" is lost with time.

Roberts Filter is entering its second half century with an ever-growing family of installations having the same capable parents to care for their every need no matter how slight.

MECHANICAL EQUIPMENT BY ROBERTS FILTER MFG. CO. DARBY, PENNA.

ROBERTS FILTER MANUFACTURING CO.
607 COLUMBIA AVE., DARBY, PA.

CONTROL
Gas Pressures

From Digestion Tanks with NORWALK REGULATORS and CHECK VALVES

Handling sewage gas from digestion tanks is one of Norwalk Valve's activities in the manufacture of gas pressure control equipment. Stock items include check valves, pressure relief valves, regulators, all sizes and pressures. Illustrated are the Norwalk Disc Check Valve and the "Meter Cop" (a Norwalk exclusive).

DESIGN AND FABRICATION OF SPECIAL UNITS

Any unusual problems can be solved by our design and fabrication of special units. Norwalk products are made with ASTM and other materials required by contract specifications.

Outline your requirements in a note to us. We'll be glad to suggest designs and special equipment. We'll also send along a catalogue of our complete line of gas control equipment.

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To obtain a copy of this bulletin on Grease Interceptors, use a Reader Service Card on which is entered the above key number and your name and address.

111

PIPE SAW

The E. H. Wachs Co., Chicago, Ill., has issued a four-page bulletin on the **Wachs National Pipe Saw.** This folder describes the pipe saw which was displayed at the A.W.W.A. Convention in Chicago last June. Photographs show how the pipe saw operates and can be used in hard-to-get-at locations. The saw will cut pipe from 12 to 48 inches and is powered by an air motor. It produces clean cuts, is fast cutting, and is portable.

To obtain a copy of this bulletin, use a Reader Service Card on which is entered the above key number and your name and address.

112

TYPE MA DIGESTER

The Dorr Co., Stamford, Conn., has issued a 4-page bulletin on **"The Dorr Type MA Digester."** The bulletin shows a sectional elevation of the digester, describes what it is and how it works, and gives sizes and design data. The type MA digester is a mechanism installed in a round, concrete tank with sloping bottom, with a draft tube suspended from the center of the gasholder passing through the center of the tank. This tube is fitted with intake ports at liquid level and discharge ports above the sludge level. A high capacity mixing unit is located on the gasholder with a shaft extending into the draft tube. The digester provides gas storage sufficient to hold 20 to 35 per cent of the daily gas production. The type MA digester has been especially designed to serve the needs of the community where single stage digestion is applicable.

To obtain a copy of this bulletin and further information, use a Reader Service Card on which is entered the above key number and your name and address.

113

FLOW METERING AND CONTROLLING

Builders-Providence, Inc., Providence 1, R.I., has issued in reprint an article by Charles G. Richardson on **"Flow Metering and Controlling For Water Filtration and Sewage Treatment Plants."**

This article is a paper which was read at the annual meeting of the Canadian Section AWWA in 1947.

To obtain a copy of this reprint, use a Reader Service Card on which is entered the above key number and your name and address.

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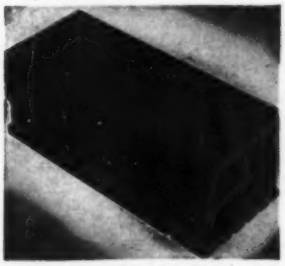

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114

JOINTING COMPOUND

The Electro Chemical Supply & Engineering Co., Emmaus (Allentown), Pa., has issued a bulletin on **Wedgetite,** the Sulphur-Base Thiokol-Plasticized Jointing Compound for Bell and Spigot Water Pipe. The bulletin describes the wafer shaped plasticized joint compound and explains the advantages not only of the wafer type of unit, but also of the thiokol which is present in the sulphur. According to the bulletin, it is the thiokol-plasticizing which makes Wedgetite highly resistant to thermal and mechanical shock from vibration with less expansion and shrinkage than unplasticized material.

For a copy of this bulletin on Wedgetite, use a Reader Service Card on which is entered the above key number and your name and address.

115

WATER CONDITIONING

General Filter Co., Box 111, Ames, Iowa, an affiliate of Layne & Bowler, Inc., of Memphis, Tenn., has issued a 3-ring, looseleaf notebook, containing information on their operations. The book is complete with catalogs on aeration, chemical feeders, demineralization filters, household water conditioning, mineral zeolites, alkalinity control, softeners, and data tables.

If you are interested in receiving one of these looseleaf binders with departmental information included on these subjects, enter your name, address, and the above key number on a Reader Service Card and mail to *Water & Sewage Works.*

116

SLUDGE UTILIZATION

The Royer Foundry & Machine Co. of Kingston, Pa., has a useful new folder, the **Sewage Sludge Utilization Datalog.** This folder contains reprints of several articles on the usefulness of sewage sludge, the application of the Royer sludge disintegrator, pictures of its operation and other useful information on the disintegration of sewage sludge for use as a soil improver.

To obtain a copy of this Sewage Sludge Utilization Datalog, use a Reader Service Card on which is entered the above key number and your name and address.

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"Copper Sulphate for Root and Fungus Control in Sanitary Sewers and Storm Drains," by John W. Hood, contains information published for the first time. This material includes actual methods for control and operating procedure. Here's the book that is a "must" for all sewage men.

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117

DIAPHRAGM VALVES

The Crane Co., Chicago, Ill., has issued a bulletin on the newest development in **Diaphragm Valves.** This bulletin shows the Crane 150 WOG, a basic improvement on conventional packless valve design. The bulletin illustrates the diaphragm valve features, the principles and the exclusive features of the new crane diaphragm valve design. A 2-page spread shows the ten features that insure unmatched performance. The bulletin also contains recommendations for service and information on materials and construction, as well as list prices, sizes and dimensions.

To obtain a copy of this bulletin on this interesting valve, use a Reader Service Card on which is entered the above key number and your name and address.

118

RESIDUAL CHLORINE RECORDER

Wallace & Tiernan Inc., Newark, N.J., has issued a folder on the **W & T Residual Chlorine Recorder.** This folder shows a picture of the residual recorder with five particular points of interest, information on what it does, its four advantages and testimonials from Houston, Chicago, and Washington, where additional recorders were installed after the first ones were purchased.

To obtain a copy of this folder or other information on the residual chlorine recorder, use a Reader Service Card on which is entered the above key number and your name and address.

119

STORY OF CHEMICALS

Diamond Alkali Co., Cleveland, Ohio, has issued a new booklet on **"Chemicals You Live By."** This interesting bulletin presents in a pictorial, as well as a descriptive fashion, information on the production of soda ash, caustic soda, and chlorine products, as well as silicates, calcium, chromium, magnesium, and specialties chemicals. For a quick education on how these chemicals are produced and how they effect your life, get a copy of this bulletin.

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DORRCO DOINGS IN 1949

1949 Again a year of uncertain progress. The definite advances made in Western Europe towards a united democratic government with a declaration of independence in another sector seem overbalanced by changes in Asia. In all they emphasize the conclusion that final peace must come from the heart, and when fear can be cast out, it will come.

At home the wave of enthusiasm brought by the sanity of the Hoover Report in midyear seems overshadowed by the deficit spending and the tight grip on one essential industry of its own dictator. Here again there are signs of revolt, but the fear of mass votes paralizes many.

It has been suggested that the wave of devaluation, a form of lèse majesté in England, and spreading over the world, may have shaken the faith of Europe in Santa Claus.

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CLASSIFICATION—Classifiers are being used for desliming and dewatering 1200 tons per hour of ilmenite sands at the unique installation of Humphrey Corp. at Stark, Fla.—entirely water-borne on barges in a dredged pit, placer-fashion. The importance of high specification sand on Federal projects is reflected by the selection of our classifiers, hydroseparators and sizers for preparing concrete sand for the Detroit Dam in Central Oregon, the Hungry Horse Dam in Montana and the Buggs Island and Clark Hill Dams in the Carolinas.

PAN-AMERICAN JIG—The jigs of Pan-American Engineering Company, recently acquired and renamed the Dorrco Pan-American placer and pulsator jigs, are well established in placer mining where their operating characteristics indicate their use may be extended into several other fields, such as iron ore beneficiation and the concentration of other minerals.

CANE SUGAR—Our orders show that there is a notable and continuing appreciation of Dorr operation and service in the cane sugar world. Factory owners look upon the Dorr Multifeed Cane Juice Clarifier and the Oliver-Campbell Cane Mud Filter as necessary units to help to solve today's high-cost-of-sugar problems.

SANITATION—Our type M sewage digester demonstrated at Stamford, Conn. the advantages of rapid mixing of sludge during digestion, and many other cities are now installing units of this improved type. A compact unit for pre-aerating sewage, combining aeration and sedimentation, is still in the development stage but appears most promising.

FLUOSOLIDS—The roasting of areseno-pyrite gold ores has been demonstrated by the successful installations at Cochenour Willans and Campbell Red Lake, both in Ontario. Major advantages are easy operation, unusually close control of temperature and sulfur content of the calcine, plus self-roasting with an unusually small amount of sulfur in the feed.

ABROAD—In Europe our associated companies in England, The Netherlands, Belgium and France have had a fine year and progress continues in the rehabilitation of the companies in Germany and Italy. Consulting work abroad, done from this country, included a magnesia-from-sea-water project in Norway, copper leaching in the Near East, an aluminum sulfate program in India and continued work in chemical fertilizers. Our far-flung interests have carried members of our domestic staff to all the nations of Western Europe, Norway, Jugoslavia, Cyprus, India, Java, Australia, the Philippines and the Far East.

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Our own year has been an exciting one in many respects. My election to Chairman of the Board with one of my oldest associates, Elmer R. Ramsey, becoming President has strengthened us, and the adoption of our "Tenure Stock" Plan in '48 has served to unite us still further.

A major undertaking has been the relocation of our General Offices in Stamford, Connecticut, with only an Executive suite with space for "Visiting Firemen", and Eastern Sales Headquarters being retained at 570 Lexington Avenue in New York, where we have been located since 1935. Looking back further, 1913 marks the date of my opening our first New York office with one Engineer.

The completion in November of our first Company film, "The Dorr Way," was a real milestone in our history. Since its mention here last year, final sequences were "shot" from California to New York, and the exacting work of editing 17,000 ft. of film accomplished. The finished film of 1200 ft. necessarily touches most lightly our work in a variety of fields. It is indeed a unique art that can happily compress many years work into 33 minutes, and still give a feeling of drama and continuity.

We have been writing again and have produced, with the greatly appreciated cooperation of many friends around the world, a revision of my book "Cyanidation and Concentration of Gold and Silver Ores," which was brought out by McGraw-Hill in 1936. This is now in the hands of the printer, and will carry the name of Frank L. Bosqui, our Chief Metallurigcal Engineer at Westport, as well as my own. When I started Cyaniding about 1900, his father's recently published book, "The Cyanide Process," was my bible.

Another associate, George D. Van Arsdale, who was for many years with Phelps Dodge and largely responsible for the metallurgical process used at the leaching plant of the Inspiration Copper Company, is compiling and editing for us a book on Base Metal Hydro-Metallurgy. This should reach the printer early in the year.

To our friends and to Dorr staff and associates we send New Year's Greetings and with them an expression of our strong faith in the future.

John V. Dorr

570 Lexington Ave., New York 22

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Chlorination, fitted to your specific needs by W&T Engineers, gives you more treatment facilities per dollar than any other single treatment adjunct. It can be put to work at your plant for less than 1% of total plant cost in most cases. And for that 1%, chlorination by W&T is on the job ready to overcome such troubles as ODORS, PLANT OVERLOAD, FILTER PONDING, GREASE, and SLUDGE BULKING, wherever and whenever they develop.

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